ANNUAL REPORT

OF THE

DEPARTMENT OF AGRICULTURE,

BOMBAY PRESIDENCY,

FOR THE YEAR

1908-1909.

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No. A.-5601 of 1909.

From

G. F. KEATINGE, Esq., I. C. S.,
Director of Agriculture,
Poona;

To

The CHIEF SECRETARY to GOVERNMENT,
Revenue Department, Bombay.

Poona, 19th August 1909.

Sir,

I have the honour to submit herewith the Annual Report of the operations of the Agricultural Department for the year ending June 30th, 1909.

CHAPTER I.

Administrative.

2. The principal posts in the Department have been held as follows during the year:—

Director of Agriculture—Myself, throughout the year.

Principal, Agricultural College—Dr. Mann throughout the year, except for the months August—November when he was compelled to take sick leave, and the post was held by Mr. Gammie and Mr. Knight.

Agricultural Chemist—Dr. Mann, except for the three months mentioned above, during which time Mr. Annett acted for him.

Professor of Agriculture—Mr. Knight throughout the year, except for the month of August when he was compelled to take sick leave, and Mr. Roberts acted for him.

Economic Botanist—Mr. Gammie till October 10th, from which date Mr. Burns has held the office.

Deputy Director of Agriculture—Mr. Main throughout the year, except the months April to June when he was on privilege leave and Mr. Roberts acted for him.

Deputy Director of Agriculture for Sind—Mr. Henderson throughout the year, except the months December and January when he was on privilege leave, and I nominally held charge of the office.

Supernumerary Agriculturist—Mr. Roberts throughout the year, who has in addition filled the gaps noted above.

Divisional Inspectors—Messrs. B. M. Desái, M. L. Kulkarni and P. C. Pátil were appointed on April 1st to the newly created posts of Divisional Inspectors of Agriculture in the three Divisions; and in Sind Mr. Gulmahommed was appointed Inspector of Experiments in March after Mr. Mahli resigned the post of Divisional Inspector in Sind.

3. These promotions caused a change of Superintendents at several of the larger farms; but the change took place at the dead season of the year, and caused no dislocation of work. For the most part the Superintendents of the other farms remained unchanged during the year.

4. From an administrative point of view the main features of the year have been

(*a*) the acquisition of Mr. Burns to fill the vacant post of Economic Botanist;

(*b*) the appointment of the Divisional Inspectors of Agriculture who have all got to work on their important duties;

(*c*) the opening of two new stations at Gokák and Sukkur, two sub-stations at Gadag and Navsári, and ten sub-stations in Sind.

(*d*) the graduation in Agriculture of 28 new students, of whom 10 have been employed in the Agricultural Department.

5. Of our Agricultural students at Cambridge, Messrs Mehta, Ajrekar and Gonehalli are expected back very shortly. Mr. Jhaveri, who went through a year's training in Entomology at Pusa, has returned and got to work; and Mr. Kulkarni, who is doing an 18 months' course in Mycology there, will return in a few months.

6. All the points noted above afford cause for satisfaction; and now that we are settling down into something like shape it may be of interest to give some figures of the staff and finances of the Department.

7. For rough purposes the staff may be divided as follows:—

Grade I—Consisting of Director, two Deputy Directors, Principal, Agricultural College, Professor of Agriculture and Economic Botanist... 7

Grade II—Consisting of four Assistant Professors and three Divisional Inspectors 7

Grade III—Thirty-six men including the Superintendents and Assistant Superintendents of Farms, upper staff of Special Branches and Inspector of Experiments in Sind 36

Grade IV—Thirty-nine non-graduate fieldmen 39

8. The Agricultural College is now taking definite shape both in stone and in staff. We have ten Agricultural Stations, a number of Sub-Stations and two Botanical Gardens. Special Chemical, Botanical, Entomological, Veterinary, Mechanical, Cotton and Wheat branches now exist, and a Mycological branch will shortly be added.

9. As regards finances our current budget stands as follows:—

Capital expenditure.	Rs.
1. Agricultural College Buildings	1,75,000
2. Other buildings	16,000
	1,91,000
Recurring expenditure.	
3. Salary	2,14,800
4. Travelling allowance	38,100
5. Petty construction	9,100
6. Cultivation charges	68,500
7. Miscellaneous expenditure	78,950
8. Contingent charges	71,400
9. Hydraulic and Agricultural experiments .	12,250
10. Cotton seed distribution	5,000
11. Destruction of insect pests	1,000
12. Demonstration and Agricultural shows ...	6,400
13. Publication of Agricultural matter ...	1,000
14. Purchase of mechanical apparatus ...	12,500
	5,19,000

The heavy capital expenditure on the Agricultural College buildings will not be completed for another three years, and meantime the expansion of the Department will be limited by our means. I have already submitted to Government proposals for the grading of the staff and an estimate of our probable development during the next four years.

CHAPTER II.

The year's work on the Farms.

10. The scope of the Departmental work has so greatly increased that nowadays it is impossible to review, however briefly, all the points of interest. A perusal of the seven appendices attached to this report will give a good general idea of the work accomplished at the College, on the Farms and in the Laboratories. For further details the Farm Reports must be consulted.

It will be seen that in the case of cotton, wheat, jowári, bájri, tur and other pulses, groundnuts, castor, til, etc., a great number of varietal tests have been made both of indigenous and of exotic crops, that selection both for quantity and for quality is being pushed forward, and that cultural and manurial experiments of considerable variety and interest have been conducted.

11. To summarise a few points briefly, it will be noted that the best cotton hybrids continue to give a lint valued considerably in excess of the local variety; and in some notable instances have obtained a higher relative value than ever before. In connection with this work it is interesting to note that we have now reached the stage of distributing seed of our best hybrid cottons. 1,500 lbs. of hybrid seed was distributed near Surat, and the growers obtained Rs. 108 per *bhár* for their cotton as against Rs. 101 for ordinary cotton. This result was obtained without any special sale arrangements being made by the Department.

12. In the Dhárwár District the cultivation of Broach cotton was for the first time undertaken on a commercial scale and was once more successful. At the auction 307 *nágas* (1 Nága = 1,344 lbs.) were sold. Prices ranged from Rs. 150 to Rs. 174 per nága, as against Rs. 116 for Kumpta. The cultivation of Broach cotton is this year being extended in fresh parts of the Dhárwár and Belgaum districts, and the cultivators are taking it up keenly. Mr. M. L. Kulkarni has written an excellent bulletin on the subject showing that, at a very moderate estimate, a net advantage of Rs. 10 per acre can be obtained in suitable tracts in the Southern Marátha Country by growing Broach instead of Kumpta cotton. It is hoped that next season the Dhárwár Agricultural Association will undertake the auction sale of the cotton and relieve the Department of this work.

13. The closure of the Jamrao Canal at sowing time made the crop of Egyptian cotton in Sind very late, and was prejudicial to its growth. The crop suffered severely later on from the very exceptional rains which occurred, and was deficient both in quantity and quality. Four thousand maunds of seed cotton were sent to Mirpurkhás for disposal; but owing to its inferior quality and the amount of leaves and dirt that was mixed with it much difficulty was experienced in selling it. Professor S. Sháhání and Sir Vithaldás Thackersey were most helpful in their offers to assist in the disposal of this cotton which was eventually taken by Messrs. Ebrahim Currimbhai and Company at the rate of Rs. 9 per maund for Abassi and Rs. 8-6-0 for Metaffifi. During the present season no Egyptian cotton has been sown as there was no water in the Jamrao at the sowing season.

14. Foreign groundnuts continue to gain in popularity in many tracts and are being widely distributed; while the advantage of sowing Spanish variety as a subordinate crop with cotton and jowári was quickly appreciated by the people round Surat. The advantages of seed selection are well brought out by the fact that in the case of jowári and maize selected farm seed gave an advantage of 200 lbs. per acre over bazár seed at Surat and Dohad respectively. With cotton too the advantages of selected seed were well demonstrated. Amongst the varietal tests the Gudhagi jowári at Dhulia, owing to its habit of early maturing, gave double the outturn of the local variety in a year when the late rains were in defect; while the trial of Párner wheat at Dohad was very promising.

15. Many references will be found to the relative merits of deep and shallow ploughing as demonstrated during the past season; and it may be as well to point out that several different questions are involved here. We have for some years past been advocating the use of iron turn-over ploughs; and

people are apt to ask in a general way "Are you certain that deep ploughing will pay?" Hitherto all that we have been prepared to say is this "Where you must plough deep in order to eradicate deep-rooted weeds, or where you habitually do plough deep, as in the case of sugarcane and other garden cultivation, or in tracts of deep retentive soil and assured rainfall, it will certainly pay you to use an iron plough rather than the heavy wooden plough; since the former will do the work better and faster." We are now trying to determine the advantages of deep ploughing for varying conditions of ordinary dry cultivation, and it must be admitted that the indications are not hitherto very clear. Deep ploughing for jowári, but not for cotton, has paid at Surat; while at Dhulia the reverse was the case. Both these experiments refer to kharif crops. The results obtained by deep and thorough cultivation on rabi crops of gram at Dohad and jowári at Ráhuri are, however, very remarkable. At the latter place the effect on jowári of deep ploughing was extremely uniform throughout the series of plots, and averaged at an advantage of 165 lbs. per acre. This is a remarkable result in a year when, as so often happens, the October rains were in defect. We cannot yet say definitely that deep ploughing would have equally good results in all seasons; and it is possible that it will be found advantageous to supplement this operation by some form of rolling or "sub-soil packing"; but the indications all point to the large net advantage which a rabi crop receives from deep and thorough cultivation. And if this is the case in our own farms which are mostly free from deep-rooted weeds, how much more is it likely to be the case when we come to the foul fields which are so characteristic of the East Deccan? There is no sight more deplorable than to see a man drilling seed into a field choked up with *hariáli*, *kunda* and *laválu*, knowing that he cannot possibly expect a good crop, and will probably obtain little or none. Such are the incidents of farming without capital. Apart from the question of deep ploughing there are other points of interest in the Ráhuri experiments, to wit, the advantages of wide drilling and a small seed rate, and the utilization of *nála* water. This latter experiment consists in the adaptation to a nála, which runs only for a short time during and after rain, of the principle of "pátasthal" so commonly employed in the West Deccan in the case of streams which run for a month or two after the close of the rains. These experiments will be repeated and extended during the present season, and offer considerable promise.

16. As regards manuring it would appear that at present prices "artificials" cannot touch farmyard manure for dry-crop farming. It is however very difficult to plan experiments with such manures which will admit of accurate comparisons being made. In other countries a farmer will often restrict his use of artificials to the demand which his crops may appear to make at some period of their growth. Thus a nitrogenous top-dressing may be used to force on a crop which is backward or faring badly for some reason. It requires a good deal of skill and experience to use them economically; and it is improbable that the Indian cultivator will have much use for them for dry crops for some time to come. It will be seen that nitre gave satisfactory results with rice and Ammonium Sulphate continues to give good results with sugarcane. We are now definitely recommending its use for sugarcane; and a good deal was distributed to cultivators during the past year. The cost per unit of nitrogen which Dr. Mann deduces from the current prices of the concentrated manures ordinarily used for sugarcane (*vide* Appendix F, page 52 *post*) shows that Ammonium Sulphate is a cheap fertilizer. Once more the remarkable residual result of the night-soil application at Surat is in evidence (*vide* Appendix A, page 28 *post*) bearing testimony to the truth of Sir F. Nicholson's dictum as to the enormous losses which India incurs through neglect to make use of this material.

CHAPTER III.

Demonstrations, Shows and District Work.

17. During the past year an effort has been made to extend this branch of the work. It is constantly said with truth "What is the use of the work on the farms unless you can induce cultivators to adopt the methods which you

find to be profitable?" It is of course impossible to hand out precise information which is of universal application to all soils in a country where the rainfall differs so greatly from one locality to another and from one season to another. Farming is not, in any case, a matter which admits of such precision. We have, however, done our best to set our ideas in order, so that we can advise generally for such conditions as garden lands in the West Deccan, black soil in the East Deccan, sandy soil in Upper Gujarát, heavy soil in lower Gujarát; and the cultivator must be content with the indications that we can offer him and adapt our methods to the circumstances of his own field and the limitations of his working capital. Demonstrations, Shows and District work all have their uses in this connection. The demonstrations are held on the Government Farms at a time when the crops are in an instructive state. A day is fixed, and the cultivators from the surrounding tract are invited; and special arrangements are made to bring in from a distance substantial cultivators who are likely to profit from what they see.

18. Demonstrations were held on the Surat, Dhulia, Dohad, Mánjri and College farms, and were attended by a number of gentry and cultivators. In particular I would mention the demonstration at Surat which was attended by 470 persons, at Dhulia which was attended by 150 persons, and at Mánjri which was attended by 5 Mámledárs and 50 substantial sugarcane cultivators from the Sátára District. Considerable interest was taken at these Demonstrations in such matters as the results of clean and thorough cultivation, manuring, spacing, rotations and implements. Various new crops were shown, and the advantages of selected seed demonstrated. It is difficult to gauge the results of such demonstrations; but I believe them to be considerable. Demands for selected seed and concentrated manures are largely increasing; and at the Surat Demonstration, orders were booked for 0 maunds of groundnut seed, seven chain pumps and three turn-wrest ploughs; while as a result of the Dhulia Demonstration Rs. 3,000 worth of Spanish groundnuts had to be obtained from America to meet the demand. In addition to the abovementioned demonstrations a practical lesson in vine pruning was given by Mr. Little in the Ganeshkhind Botanical Garden; and a party of gentlemen from the Southern Marátha Country were accommodated for a few days on the Mánjri Farm and Ganeshkhind Garden and given a demonstration of our system of sugarcane cultivation, gul-making, sugar-making and the management and use of oil-engins for cane-crushing and pumping.

19. In the matter of Shows also there has been a considerable extension Agricultural shows of some magnitude were held at Dhárwár, Nadiád (Kaira District), Shirála (Sátára District), and Ahmednagar, while departmental exhibitions on a smaller scale were undertaken at Ahmedabad, Panvel (Kolába District), Sholápur, Shrigonda (Ahmednagar District), Godhra, Peint (Sátára District), Hyderabad (Sind), Talhár (Hyderabad District), and Shikárpur. At Dhárwár, Ahmednagar and Panvel, the Agricultural show was combined with a cattle show; at Ahmedabad, Talhár and Shikárpur it was combined with the annual horse shows held at those places; at Sholápur with the annual cattle fair; and at Hyderabad and Godhra an Agricultural section was added to the general exhibitions that were held there. At Dhárwár, Nadiád, Ahmednagar and Shrigonda, the local Agricultural Associations undertook a great part of the organisation of the shows, and at other places we received much help from local committees formed for the purpose, and from the local authorities. At these shows prizes were given both for cattle and for produce; and in many cases the exhibits were excellent both in quantity and in quality. Departmental exhibits were also put up of crops suitable to the locality; and entomological and mycological sections were well organised, and matters explained to all comers. Various processes such as improved gul-making and seed-pickling were demonstrated, and many improved implements and machines were shown in motion; while at the Ahmednagar show we had a seed stall where orders for various kinds of selected seed were booked. In the case of Sind the implement section was a special feature and its success will be judged from the fact that some 200 improved implements were disposed of with ease. These were manufactured at the workshop at Mirpurkhás, which fully paid its own way, and was unable to meet the demand that was created. At several Shows,

also, Messrs. Kirloskar Brothers of Belgaum exhibited their agricultural implements. At all shows lectures were given on Agricultural and Veterinary matters and in many cases leaflets dealing with the subject of the lecture were distributed. These shows attracted enormous crowds of people, thus serving to put us in touch with large numbers of cultivators; they were, I think, generally appreciated. In several cases favourable notices of our shows and demonstrations appeared in the Press.

20. As regards district work the staff of several farms and particularly at Surat, Dhárwar and Nadiád took up district work in the vicinity of the farm; while it was possible to spare a fieldman for district work in each of the four districts, Poona, Nagar, Sátára and Sholápur; and towards the close of the year the newly created Divisional Inspectors were able to supervise all such efforts, and to inaugurate fresh work of this nature on an extended scale.

21. It is difficult to assess the relative value of demonstrations on farms, shows and district work by an itinerant fieldman. At farm demonstrations only cultivators and those really interested are present; so more individual attention can be given to them; and the opportunity is a good one for impressing skilled cultivators with the fact that the Department is a practical concern which can grow excellent crops; while at a big Show large crowds of people witness the work of the Department; and those really interested must return later on for any more detailed information which they may require. An itinerant fieldman can get into close touch with a few good cultivators and devote time to thoroughly inculcating improved methods, hoping thereby to make some centres from which the knowledge thus imparted to the few will spread to the many. Perhaps the best plan of campaign is a combination of all these methods. We were able to undertake such a campaign during the past year in the south of the Sátára District. Proceedings opened by the visit of 50 cultivators and 5 Mámledárs for two days to Poona where they were taken over the College and Mánjri Farms, and shown our system of sugarcane cultivation and gul-making. This was followed by several visits of the Divisional Inspector of Agriculture to the tract, accompanied by a fieldman, who was set to work there for the season. Mr. Knight and myself subsequently made tours in this locality, and we ended up in April by a large show at Shirála. There were four matters of prime importance that we had to show

(1) that the use of the Poona furnace for gul-boiling will save about Rs. 30 worth of fuel per acre of sugarcane cultivated as compared with the Sátára furnace;

(2) that an iron plough with 4 bullocks will work the heavy soil of the locality faster and better than the heavy wooden plough with 8 or 10 bullocks;

(3) that nitrogenous top-dressings for sugarcane are very profitable;

(4) that to treat jowári seed with sulphate of copper, costing 1 anna per acre sown, will often give a profit of a hundred-fold and more.

As a result of our operations many people have adopted the Poona furnace and several have written to say that in the first year it saved them considerable expenditure on fuel; several people tried nitrogenous top-dressings for sugarcane, and at the Shirála show spoke well of their effect; the value of the iron plough was generally admitted; and many people have expressed their intention to dress their seed with copper sulphate. In short we have now got into close touch with a very highly cultivated tract, where the people are most receptive of new ideas; but were before hardly conscious of the existence of the Agricultural Department, or its teachings. As regards the adoption of the Poona furnace for gul-making in the Sátára district I will here give the translation of an extract from a letter received from Bhau Pátil of Kásegaon in the south of the Sátára District, *viz.*:—

"The gul-making process adopted at the Mánjri Farm has been tried in my field with advantage. The boiling pan and construction of the oven after the Poona pattern have been ound to be superior to the method in use in these parts. This fact has been acknowledged by

many cultivators here. The area of sugarcane dealt with was 2 acres 10 gunthas, and 48 boilings were made. With the ordinary Sátára method the megass would supply fuel for 24 boilings, and fuel for the other 24 would have to be purchased, costing Rs. 3 per boiling, or Rs. 72 in all. By the new process it was only necessary to purchase fuel for 4 boilings, costing Rs. 12 in all. There was thus a clear saving of Rs. 60. The fieldman and gul-making experts of the Agricultural Department did their work very well, and we are grateful for the assistance given."

This opinion from a very practical and intelligent pátil who farms in a large way in a fertile tract is well worth having; and it must be remembered that it refers to a matter in connection with which lákhs of rupees are annually wasted, particularly in the Sátára and Belgaum districts. It was Mr. P. C. Pátil, Divisional Inspector of Agriculture, Central Division, who first brought this fact to notice.

22. In Sind a notable departure has been made by the establishment of a number of sub-stations; and the three graduate fieldmen who have hitherto been serving an apprenticeship on the Mirpurkhás Farm were each put in charge of a group of such sub-stations. The groups are as follows:—

(1) Lower Hyderabad.
(2) Upper Hyderabad.
(3) Sukkur.

At the head-quarters of each fieldman a building is being fitted up as a store for seed, implements and literature, and a standing exhibition of Agricultural produce. In north Hyderabad there are 4 sub-stations, *viz.*, Kandiáro, Nowsháhro, Daur and Hálla. In south Hyderabad there are three sub-stations, *viz.*, Tándo Mahamadkhán, Tándo Bágo and Badin. In Sukkur there are three sub-stations, *viz.*, Shikárpur, Páno Akil and Mirpur Máthelo. At each of these sub-stations a plot of 10 acres belonging to a Zemindár is laid out for demonstration purposes, and is supervised by the Department, the zemindár getting the cultivation done and taking the produce. Such crops as American and Dhárwár-American cotton, Chapti jowár, groundnuts and pulses are being introduced where they were unknown before; and a special point is made of the advantages of good cultivation, and proper rotations. This is a cheap and effective method of inculcating simple lessons; and is suited to the conditions of Sind.

CHAPTER IV.

Publications.

23. It was stated in last year's report that we intended to undertake a number of short publications with the object of placing before the cultivators important points on which we were prepared to offer information. The following publications have been issued during the past year:—

Bulletins.

(1) Bulletin No. 30 of 1908 on "Field, Garden and Orchard Crops of the Bombay Presidency," by Mr. G. A. Gammie.

(2) Bulletin No. 31 of 1908 on "The establishment and management of a Dairy Farm," by Mr. G. K. Kelkar.

(3) Bulletin No. 32 of 1908 on "Locusts in India," by Mr. H. M. Lefroy.

(4) Bulletin No. 33 of 1909 on "Cultivation of Broach Cotton in Dhárwár" (with a Kánarese version), by Mr. M. L. Kulkarni.

(5) Bulletin No. 34 of 1909 on "Night-soil—a Valuable Manure," by Mr. G. K. Kelkar.

Leaflets (with vernacular versions).

(1) Relative profits from gul and sugar making.
(2) Instructions for the cultivation of Bourbon cotton.
(3) Particulars of a new plough suitable for Sind.

(4) The sugarcane borer.

(5) The potato worm.

(6) Co-operation amongst cultivators to protect crops from damage caused by insects.

(7) The cotton boll worm.

(8) The scraper for levelling land.

(9) Manures for tobacco.

(10) Broach cotton in the Southern Marátha Country.

(11) A note on the cultivation of Broach cotton at Dhárwár.

(12) A cheap fodder for the hot weather.

(13) A practical system of storing farmyard manure.

(14) Fodder crops—Sundhia.

(15) The Norag or Threshing machine.

(16) Iron ploughs.

(17) Sugarcane-crushing.

(18) Potatoes.

(19) Sugarcane.

(20) Destruction of paddy in the store-house by the Surma.

(21) New implements on the Mirpurkhás Farm.

(22) Lucerne Dodder.

(23) How to grow Papaya.

(24) The Poona gul-making furnance.

The leaflets have been prepared by many members of the staff; and the series edited by Dr. Mann. We hope to constantly add to the number already published.

24. No doubt much of the information contained in any one of these leaflets is known to good cultivators of certain tracts; but it is remarkable how the cultivators of one tract are often ignorant of facts that are a matter of common knowledge to the cultivators of another tract. Thus the sugarcane growers of the Sátára District do not know the use of oil-cake as a top-dressing, so generally adopted in the Poona District; the cane grower in Kánara, who has fish manure at his door, does not use it, while the Deccan cultivator will bring it up from the coast. A cultivator in one village will continue to crush his cane with a wooden mill, ignorant that he is losing juice worth Rs. 60 per acre of cane grown; a fact that his neighbour has known and acted upon for many years. Potatoes so widely cultivated in some parts are unknown in many places where they might be profitably grown; and in a corner of the Bijápur District a man who had learnt the mysteries of turmeric growing refused to disclose his exclusive knowledge to his neighbours. I think that the leaflets will be of use to the cultivators; they certainly are to the Department. A set of the leaflets mentioned is submitted for the information of Government.

CHAPTER V.

Agricultural Mechanics and Engineering.

25. The mechanical branch has during the past year commenced its operations, which fell mainly under two heads:—

(*a*) Well-boring in Gujarát.

(*b*) Trials with oil-engines for water-lifting and cane-crushing in the Deccan.

26. *Well-boring.*—As mentioned in the last report, well-boring was commenced in Gujarát during the preceding year with tools of the kind that have been in local use for a long time in Gujarát, with the addition of a few implements which were calculated to assist the work. With these tools the *modus*

operandi is as follows; a pulley is erected over the well to carry a stout rope with a long iron bar attached. This bar is armed with a chisel and is worked inside a 3-inch pipe by coolies on the rope, who jump the bar up and down inside a vertical pipe. When a certain amount of the soil at the bottom of the pipe has been broken up in this way the bar is pulled up and the chisel removed from the end, and a mud shell substituted, to allow the removal of the soil that has been broken up. This process is constantly repeated; and as the excavation gets deeper fresh lengths are screwed on to the iron bar. Meantime the pipe has to be forced down into the excavation, to make a lining for the bore hole. This is done from time to time as the earth is removed, and is effected by banging a heavy block of wood on the top of the pipe and so forcing it down the hole. As the bore gets deeper fresh lengths of piping have to be screwed on at intervals. By this elementary process, which is well known to the people in some parts of Gujarát, twelve borings were made at the bottom of wells, to a depth which extended in some cases to 70 and 80 feet below the bottom of wells already 50 feet deep. Of these twelve borings one was moderately successful, in two cases a little water was obtained; and in nine cases no water was obtained. This lack of success was not entirely due to the inefficiency of the tools, since several deep borings were made without any mishap but no water was obtained. They were made however in a locality which we now know to offer very doubtful prospects of obtaining sub-artesian water. As regards the efficiency of these tools it may be stated that they work very slowly, and the average cost of boring with them amounted to just over Rs. 3 per foot (excluding the cost of piping); while in the case of one boring the cost amounted to nearly Rs. 6 per foot. The worst point about them, however, is that accidents are very liable to occur which render useless all the previous work done in the well. The principal accidents which are liable to occur are these:—

(*a*) In changing the chisel for the mud shell, and *vice versâ* or in screwing on new lengths of the iron bar the work is apt to be done carelessly and the joint not made tight; with the result that the tool or a length of the bar bearing the tool may get left behind in the bore hole; and when the bore hole is over 50 feet deep it is almost impossible to fish them up.

(*b*) In hammering down the pipe it is liable to burst at some of its couplings.

Either of these accidents means a complete waste of the labour and materials expended on the boring, and the work has to be abandoned or begun afresh. I think that the slowness of the work done by these tools, the liability to such accidents, and the uncertainty of striking water explain the reason why this apparatus, though spasmodically employed for years past both by people and Government, with occasional success, has never become generally popular.

27. During the rains of 1908 Mr. Nagindás, the Overseer, who had recently been placed in charge of these operations, was deputed to Cawnpore to study the well boring operations in the United Provinces and learn the use of their apparatus; and on his return in September he at once got to work with a set of the Cawnpore tools which speedily demonstrated their superiority to the old ones. Three more sets of Cawnpore tools were ordered, and after a short time the use of the old tools was almost abandoned, since the well owners round Nadiád who had seen both sets at work, and were impressed with the advantages of Cawnpore tools, were unwilling to have the old tools used on their wells; preferring to wait till a Cawnpore set was available. It may here be mentioned that the object aimed at is to make a boring at the bottom of an existing percolation well with the object of striking sub-artesian water which will deliver, up the bore hole, at least to the level of the well bottom. The *modus operandi* with the Cawnpore set is as follows:—

The general principle of breaking up the soil by a chisel worked by coolies on a rope over a pulley is the same; but in this case two vertical pipes are used. The larger pipe ($2\frac{1}{2}$ inches) is kept full of water, and inside it a smaller pipe ($1\frac{1}{4}$ inches) is jumped up and down. This smaller pipe has attached to the

bottom of it a chisel, in such a way that the bottom end is kept open and admits the water, while the top end is fitted with a sludger. The chisel breaks up the soil which mixes with the water, and in this state squirts up the small pipe and is ejected at the top by the sludger. The advantage of this method is that it obviates the necessity for the use of the mud shell, and so saves the constant changes of chisel for mud shell, and *vice versâ*. This saves time and greatly decreases the risk of dropping the tools into the boring. Further the fact that the excavation is carried out in wet ground instead of in dry ground enables the large pipe to sink with little or no hammering, and so the risk of bursting it at the couplings is eliminated. The Cawnpore set can be used in a well which contains water; and the only limitation which it has, as compared with the old tools, lies in the fact that it can only be used in earth and sand, and does not work in rock or even in stony ground or murum. The old set is able to tackle some amount of soft murum. It must therefore be clearly recognised that we can only work in earth and sand; and not in rock, stony ground or murum. There are, however, large areas in Upper and Lower Gujarát where conditions are suitable to our requirements. With the Cawnpore tools 25 wells have been bored, and in three cases two borings were made in a single well. The borings in the case of 15 out of these 25 wells have been successful and in the case of 10 unsuccessful, while the average cost of boring averaged Rs. 1-7-1 per foot, exclusive of the cost of the piping used, which in the case of the successful wells may be taken at about Rs. 1-4-0 a foot. In the case of one of the unsuccessful wells water was struck but it would not rise quite as high as the bottom of the well. If the well is deepened this failure will be converted into a success. In some cases wells which formerly had enough water to work only one kos now have enough to work two, three, five or six *kos*, while in others, wells which formerly had sufficient water to admit of two kos working will now provide for five or six.

28. Up to the present we have spent on this work about Rs. 13,000, a great part of which was used up in the purchase of the original tools which gave so little success; and about Rs. 1,000 has been recovered. I do not regard the money as wasted even in the case of the old tools, since we could not have obtained the knowledge otherwise.

29. The greater part of the borings were done in the neighbourhood of Nadiád, and the results obtained were very varied, and somewhat confusing. Very different strata were found at places only a mile or two apart, and we have learnt that in a great part of this locality such borings are unlikely to give satisfactory results; and that if water is not struck at a depth of about 100 feet it certainly does not pay to carry them to a further depth, as we have done in a number of cases. On the north of Nadiád however we have found a locality which gives indications of a really good sub-artesian supply. At Umreth in the A'nand Táluka our only two borings were successful and the subsoil strata appear to be uniform, encouraging the belief that this may be a suitable tract; while at Báreja in the Ahmedabad District the one boring gives very hopeful indications. In the neighbourhood of Surat five wells out of six were successful, and point to the probability of moderate success for this work; while in the Jalálpur Táluka it is found that rock occurs at a depth of about 100 feet; and operations there will be discontinued. When the monsoon brought the work to an end one set of tools was lent to the Umetha State (Rewa Kántha Agency), while two sets have been taken down to the south of the Bijápur District, and experiments will be made there and in parts of the Dhárwár District.

30. To sum up, we have now got some simple tools which work well, and we have obtained some definite indications regarding subsoil water. I hope that by the end of the next season we shall be able to get out a subsoil water chart for several localities and to say to the people of those parts "There is almost certainly sub-artesian water at a depth of 100 feet below the level of your field, and if you will have a 50 feet boring made from the bottom of your well you will get a good supply of water. The cost of this, including piping, will only amount to from Rs. 2 to Rs. 3 a foot."

31. The cost of labour has been very high; and with more efficient organisation I have no doubt that we shall be able to expedite the work and to

reduce the expenditure. It has not been possible to devote much time to supervising this work; and Mr. Nagindás, the Overseer in charge, deserves much credit for the results he has obtained. The tabular statement showing the work done and cost incurred, the maps of the localities, showing the wells, and the charts of the subsoil strata will be submitted separately to Government. They are of much interest.

32. *Trials with Oil Engines.*—In August 1908 we obtained the services of Mr. D. G. Apte, the Mechanical Assistant; and several oil engines and pumps were purchased for trial. Such pumping plants have been at work in various parts of the Presidency for some years past, and we have formerly demonstrated the fact on our farms that an oil engine will lift water at about half the cost of bullock power from a well with a really good water-supply. The object of the present venture was to see how far such pumping plants were suitable for lifting water economically from rivers in the Deccan, the water of which could not otherwise be made available for irrigation; and we also wished to prospect for suitable pumping sites, to advise the cultivators in such matters, to assist in the setting up and repair of such machines, and to train people to run them. The conditions which make for success are the following; a good perennial water-supply, a low lift, sufficient good land under command, with the right slope to admit of a short lead of piping, and a location on the river bank which is immune from flooding. There are plenty of places in the Deccan where such conditions exist, and many such places were surveyed on the Bhima, Krishna, Ghataprabha, Mula and other rivers. Only one other thing is wanting to ensure success, *viz.*, that the riparian owner shall be an intelligent and enterprising man with some capital at his command. Such men are to be found, but unfortunately their land is seldom located in the best situations. In two cases where we had arranged with the consent of the owners to set up 14 B. H. P. oil engines and 5-inch pumps at our own cost for purposes of experiment and demonstration, and had actually brought the plant to the spot, the riparian owners at the last minute declined to allow us to proceed.

33. The only pumping plants that we erected were:—

(*a*) At the Ganesh Khind Botanical Garden a fixed 8 B. H. P. oil engine (Fieldings) and a 3-inch centrifugal pump to lift water from the Mula river. Lift 30 feet, lead of piping 250 feet.

(*b*) At Ghotavada, 18 miles from Poona a $6\frac{1}{2}$ B. H. P. portable oil engine (Ruston Proctor) and a 3-inch centrifugal pump, lift 25 feet, lead of piping 350 feet.

Both have worked satisfactorily and in the case of (*a*) the plant was found to lift 9,000 gallons per hour as against 10,000 gallons claimed by the makers as the discharge for optimum conditions; but I am unable this year to give a full financial statement to show how far they have worked economically. Pumping plant (*a*) was used to irrigate fruit, flower and vegetable crops in the Botanical Garden, and also served for the instruction of persons who wished to learn the management of oil engines. Pumping plant (*b*) irrigated sugar-cane, maize and rice during the past hot weather. Both plants were managed by boys on a pay of Rs. 15 per mensem whom we had trained for the purpose. I may mention however that the situation of neither of these plants is so advantageous as others that I have since discovered. A large number of such pumping plants have been erected in the Poona District by private individuals, mainly to pump water from wells and canals, and are approved of by the owners; and several have lately been erected to pump water from rivers; while many more of such undertakings are in progress or are being projected. In many such cases we have been able to give advice and assistance to those interested. I would here call attention to the fact that pumping from rivers offers a much greater scope than pumping from wells and canals. The water of the latter would be used in any case; whereas the water which remains in the many large reaches of the Deccan rivers can very seldom be drawn up by a *mot* owing to the configuration of the river bank and the damage done by the monsoon floods to any *budki* that may be constructed. This vast source of water-supply therefore now goes to waste; and our work will be to see that it is

used. There are already working on rivers near Poona a 37 B. H. P. suction-gas plant driving a 6″ pump, and a 14 B. H. P. oil engine driving a 5″ pump.

34. From a study of many riparian situations in the Deccan, and the working of existing pumping plants belonging to the Department and to private gentlemen I venture to submit the following four cases, which I think are typical of suitable situations which are to be found all over the Deccan, and answer to the needs and capacity of the cultivators. Against each plant I have entered the area of sugarcane that the plant is calculated to irrigate after allowing for loss by seepage and some inefficiency in working; and have estimated the cost of lifting the water per acre of sugarcane, allowing for interest and depreciation on outlay, cost of fuel and management:—

Plant No. 1.

6½ B. H. P. oil engine and 3″ centrifugal pump. Maximum lift 25 feet.

Area of sugarcane irrigated 20 acres.

Cost of water per acre Rs. 80.

This plant is suitable for a man of small capital, for use on one of the small rivers in the West Deccan, such as the Mula, Indráyani, &c.

Plant No. 2.

10 B. H. P. oil engine and 5″ centrifugal pump. Maximum lift 25 feet.

Area of sugarcame irrigated 64 acres.

Cost of water per acre Rs. 40.

This plant is suitable under the same conditions as Plant No. 1, and for a river like the Ghataprabha in the Bijápur District, for a man with more capital.

It will be seen that it gives much more economical results.

Plant No. 3.

14 B. H. P. oil engine, with 5″ centrifugal pump. Lift 40 feet.

Area of sugarcane irrigated 64 acres.

Cost of water per acre Rs. 49.

Suitable for larger rivers towards the east of the Deccan, such as the Bhima and Krishna.

Plant No. 4.

37 B. H. P. suction-gas engine and 8″ centrifugal pump.

Area of sugarcane irrigated 144 acres.

Cost of water per acre Rs. 29.

This plant is suitable for the same conditions as plant No. 3 but the initial outlay involved will restrict its use to men of means, or to associations of cultivators. It should prove most profitable.

35. I have calculated the whole of the irrigated area in terms of sugarcane cultivation, since this offers a convenient unit; but of course a great part of the value of such pumping plants will lie in giving an occasional watering to cereal and other crops in years when the rainfall is deficient. A watering of sugarcane is taken as 45,000 gallons per acre every 8 days; and that is a suitable average watering for Deccan conditions. It may be mentioned that the Irrigation Department charge from Rs. 25 to Rs. 50 per acre for sugarcane irrigation; and the cost of irrigating an area of sugarcane by the ordinary *mot* may be taken at about Rs. 125 per acre. As already stated, the above figures are not results deduced from actual operations, and they cannot at present be guaranteed. Each of the pumping plants mentioned above will be erected in a suitable situation in the course of the next few months, and the financial results will be carefully noted; but complete conclusions cannot be arrived at till we have some years' experience.

36. *Oil engines and cane crushers.*—A full account of this work will be found in Appendix C. The new cane crusher has given good results and is to be purchased by a gentleman at Bárámati, while two more cane growers in the

Nira Valley have asked us to obtain power crushers for them; and we have placed the orders for them with an American firm. A gentleman near the Mánjri Farm is also setting up a power crusher for himself similar to the one we have. The fact that, after carefully watching the operations of the power crusher, a number of the best cane growers are anxious to procure them for themselves is better evidence of their value than any departmental statistics would be. They certainly do the work cheaper and get a better juice extraction. On this latter point several competent cane growers who watched the operations of the new crusher in the Nira Valley summed up the results by saying that with the help of the power crusher cane gave ten cart-loads of gul which would ordinarily give only nine. The difficulty of obtaining labour in the crushing season is such that a large part of the cane in the Nira Valley was this year still standing when the monsoon burst, for want of labour to crush it. Power crushers will save a great part of this difficulty. I here give a copy of a letter, dated 5th August 1909, from P. Bunter, Esquire, B.A., LL.B., High Court Vakil, on the subject of the cane crusher on the Mánjri Farm. It is interesting as giving the experience of an independent cane grower:—

"I have a farm adjoining the Government Experimental Farm at Mánjri, and have been cultivating sugarcane for a number of years. Last year I made a departure from the usual method of crushing the cane, and it was taken to the Government Farm to be crushed by the oil engine. My actual experience has realised the advantages which the officials on the farm claimed for the method of crushing by means of the oil engine.

Firstly, those who value their time will consider it no small gain, when I say that it took about a third of the usual time to crush the crop. To be more definite, it takes about three months for this operation, but last year I finished this part of my work in a little over three weeks. Those who are engaged in the cultivation of this crop will need no special pleading to realise this advantage.

It is a fact which every cultivator knows that the Irrigation Department will not allow the new crop to be put in till the standing one is removed; sometimes concession is made in favour of the cultivators, and they are allowed to put in as much area as has been removed; and they are not asked to wait till the whole crop is crushed. When a cultivator has to wait till the old crop is removed, the planting of the new sugarcane crop is necessarily delayed. It is also a recognised fact that during the hot season the crop generally suffers for want of water; according to the Irrigation Department rules, sugarcane crop is allowed water after every 10 days, but during the hot season (through no fault of the Department) after 14 days or so the crop is watered. A crop which is only two months old will naturally suffer more than a crop four months old. The Irrigation Department allows water to the sugarcane crop for 12 months and if the crop is watered after that period, an extra charge is made for three months; even if the crop is removed in a month after the year has expired. The cultivators begin to crush the cane when it is about 12 months old and invariably the crushing operation takes a month or two, with the result that they have to pay for a quarter extra. All this I saved this year.

The second head is the saving effected in the fodder. All the sugarcane tops are consumed by the bullocks which are employed to work the (old) crushing machines. Every machine needs 8 bullocks and the labourers generally smuggle two or three cattle more. Annually I work two machines, the total numbers of cattle that are fed by this process for three months is about 22. I have been able to save the fodder which would be sufficient for 22 bullocks for 3 months. This is not a small item with an agriculturist.

The third head is the most important of all. By the old cruhsing machine a good quantity of juice is left in the husk and this is a serious waste. When the officials on the farm told me that by the oil engine there would be a saving of about 8 per cent. of the juice, I was a bit sceptical but my experience has taught me that this was literally true. After comparing the figures of the produce of the year previous with that of the current year I can roughly say that there has been a saving of about 6 per cent. to 8 per cent. in the juice.

I do not propose to hold a brief for the oil engine but wish to state all the facts dispassionately. The expense of crushing by the oil engine is a little more than by the other method as the cost of carting sugarcane to the engine is an extra item but weighing this with the advantages it is a negligible quantity. In conclusion my best thanks are due to Professor J. B. Knight for allowing me to crush my crop on the farm and for the many valuable hints and suggestions he made to me from time to time. I am also grateful to Mr. K. T. Shinde, the Superintendent of the Farm, for rendering me all the help he could."

37. Apart from the abovementioned activities of the mechanical branch we are taking up many smaller matters. We did some work in well deepening in the Deccan with the ordinary jumper bar which has been used with success by the district staff in many localities; and after the monsoon we propose to try the experiment which has done well in the Bijápur District, *viz.*, to torpedo bore holes in rock with gelignite. We are putting up an experimental pumping station on the College Farm at which we mean to test many different kinds of water lifts at different heights such as the ordinary *mot*, the Gujarát

kos, the chain pump, the Persian wheel (two types), the *Noria* (two types), the hot air engine, etc. Indeed the field for mechanical experiment is without limits; and we badly want a workshop to assist in this matter.

38. *Agricultural Engineering.*—Apart from mechanical work of the nature indicated above there are many matters which demand the attention of the Agricultural Engineer. The reclamation of salt lands is mentioned in Appendices B and F and the principle of *nála* bunding is described in Appendix C-1. In addition to this several distinct lines of work in connection with *tál* building, field terracing and *Bonificazione* have been taken up by other Departments in different parts of the Presidency. This Department is shortly to obtain the services of an Engineer and I think that it may confidently be said that he will find a vast field in which to labour.

CHAPTER VI.

Agricultural Associations.

39. The following additional Agricultural Associations have come into existence during the past year:—

1. Jámkhed (Áhmednagar District).
2. Kumpta (Kánara District).
3. Bijápur.
4. Belgaum.
5. Nipáni (Belgaum District).
6. Chikodi (do.).
7. Panvel (Kolába District).
8. Bhimthadi (Poona District).
9. Yeola (Násik District).
10. Nandurbár (West Khándesh).

Experiments have been laid out and are being undertaken by the members of Nos. 2, 3, 4, 5, 6 and 7 under the advice of Agricultural Officers. A fieldman of this Department has been lent to No. 3; while a graduate fieldman is being trained to take up independent work in connection with No. 2. No. 7 organised a show of its own. Amongst the older Associations those at Nadiád, Dhárwár and Ahmednagar organised large shows; and the small society at Ránder did some experiments under the guidance of Mr. Bhimbhái, Superintendent of the Surat Farm.

40. The formation of a number of new Agricultural Associations is a hopeful sign, showing that the public are beginning to take an interest in the work of the Department, and to realise that progress in agriculture is possible. Until this feeling exhibits itself amongst land owners and cultivators, the utility of this Department must of necessity be very restricted; and we have done our best during the past year to foster it by means of demonstrations, shows, meetings and field work; and, I think, with some success. The formation of an Association should be regarded not as a substitute for individual effort, but rather as an expression of it. Whether an Association exists or not it is the keen and active individual that we want; but, given him, the Association is a good vehicle for the expansion of his activities. In the past some associations have been formed, and have shown no further sign of life; some have organised shows, and some are conducting field experiments under our guidance. I am far from saying that the work done by these associations and the gentlemen who stand behind them is not of value, and I would in particular mention the useful work which is being done or projected by the following:—

The Desái family of Nadiád.
Mr. V. A. Gupte and Mr. S. R. Modak of Ahmednagar.
Mr. S. G. Páregáonkar of Sangamner.
Mr. Mugáppa Savdatti of Dhárwár.
Mr. Y. V. Randive of Panvel.
Mr. G. R. Másur and Mr. R. V. Padbidri of Kumpta.
Mr. V. S. Mutálik and Mr. A. J. Deshpánde of Bijápur (Muddebihál).
Mr. A. M. Bidikar of Belgaum.

41. But it generally happens that the progress made by Agricultural Associations varies in direct proportion to the assistance that this Department is able to give them. We are most anxious to help them all to the full extent of our powers; but we want the work of each association to represent its own activity rather than ours. The area which we have to cover is so large relatively to the strength of the Department that it is quite impossible for us to make ourselves felt throughout without active local initiative. In some places we may be able to sustain our efforts for a whole season; in others we can manage only a short visit and perhaps an exhibition; while in most we are totally unknown to the cultivators. In no country, however, does an Agricultural Department attempt to do the whole work single handed; and even when the staff is far larger and the area to be covered far smaller than with us, the work of an Agricultural Department can hardly be more than helping the people to help themselves. Our watchword must be "local initiative and central direction," doing our utmost to evoke and fortify the enterprize and self-reliance of the agriculturists on the one hand, and on the other guiding and assisting the efforts that are made, and bringing them into some sort of relation and co-ordination with each other. It is for such work that we want keen and active volunteers; and fortunately we are able to appeal to many interests. There are some to whom the scientific side of improved agriculture will appeal, and who, without taking very much interest in the economic effect may find a most fascinating occupation in the pursuit of certain branches of intensive cultivation. There are others who are anxious to obtain the largest return possible from their land. This is a class to whom we can confidently appeal. Others again may say "We get a fair living from our land, and do not want to be troubled with new methods." To them we would say "Though your circumstances may not compel you to take trouble for yourself, we would ask you to do so for your poorer neighbours." I believe that there are many who would respond to this appeal, though they would not take the trouble on their own behalf. These are the men that we want most of all.

42. To come to practical proposals; what have we got to suggest? We have now obtained at our agricultural stations a mass of information regarding cultural methods, manures, implements and crops. There is hardly a staple crop with regard to which we cannot give valuable advice and supply selected seed. Years ago Mr. Mollison recommended a manure for rice; but it has never been adopted. Years ago he demonstrated that a wooden sugarcane mill fails to extract 10 to 15 per cent. of the juice that an iron mill will extract. Yet many a cultivator continues to use the wooden mill, ignorant that he is yearly burning with the megass Rs. 200 to 300 worth of juice which he might easily extract. Take again the question of seed selection. What is the use of our obtaining an improved seed on the Government farms unless the cultivators learn the principles of selection and will maintain the standard reached? And if such matters are crying for demonstration in highly cultivated tracts how much more does the need for instruction arise in the backward localities where the fields are choked up with weeds, and little or no effort is made to utilise the subsoil water. To all who are willing to help we would say "Come to our agricultural stations and we will show you our methods, and give you advice and literature, supply you with improved implements, seed and manure, and show you how to obtain the same for yourselves; we will explain the nature and remedy of insect pests and plant diseases, and show you the best way to improve and husband your water-supply." Nor is it only in matters of cultivation that we can assist. The manufacture of gul, the grading of crops, such as cotton and groundnuts, the co-operative purchase and efficient storage of seed potatoes and similar articles, all offer a profitable field for effort. A great advance can be made if only the simplest lessons are learnt and driven home, such as the proper conservation of farm yard manure, the conservation and use of urine and night soil, the efficient storage and economical use of fodder, and the first principles of cattle breeding. If those willing to help in the work will come to our stations and find out what we have to show them, and will commence the campaign in their own villages, we will do all that we can to make their efforts a success; but we badly require some local initiative to help the matter along.

CHAPTER VII.

GENERAL.

43. In conclusion, I have only to acknowledge a strenuous year's work on the part of the staff of this Department.

44. Dr. Mann has brought the College successfully through the first year of its independent existence, and has shown his customary energy and ability both in the management of the College and in his work as Agricultural Chemist.

45. Mr. Knight has put in a very hard year's work at the College, on the farms and in the District. His district work in particular has very greatly expanded in several useful directions. At Shirála he was able to put into the field a staff, trained by himself, at the College and on the farms, which ran through an important and successful show at a spot remote from any of our centres. The results of the show bore testimony to the practical nature of the past work which he has performed in this Department. His miscellaneous duties are at present almost overwhelming; and I hope that it will soon be possible to relieve him of some of them.

46. Mr. Burns has settled down well to his work at the College, and has started some important lines of investigation in the Botanical Gardens that promise valuable results.

47. Mr. Main has supervised the heavy work on the farms under him with much care, and the farm reports which he submits clearly show his capacity as a scientific and as a practical investigator. The area which he has to cover, from Ahmedabad to Dhárwár, makes it impossible for him to get much in touch with the country remote from the farms; and I hope that it will soon be possible to relieve him of part of his charge, which is too large for one man to supervise.

48. Mr. Henderson is bringing to a most successful conclusion his work of alkali land reclamation in Sind; and has developed a very useful and practical line in the creation of a number of sub-stations designed to bring home to the people the advantages of good cultivation and proper rotations.

49. Messrs. Bhimbhái, Kulkarni and Pátil, the Divisional Inspectors in the Presidency proper, and Mr. Gul Mahommed, Inspector of Experiments in Sind, make a body of capable and energetic assistants from whom we expect great things as soon as they settle down to their new duties of Divisional Inspectors. They have all put in an excellent year's work; as also have the College staff. Of the Farm Superintendents only Messrs. Tagáre (Nadiád) and Káshináth Shinde (Mánjri) have served for long in this Department. They carefully managed their farms during the past year, and Mr. Tagáre did a good deal of outside work and took a leading part in making the arrangements for the large show held at Nadiád.

50. The rest of the superior staff is mainly composed of junior men; but many of them give promise of becoming valuable workers, and most display considerable keenness and enthusiasm. Indeed the general spirit which pervades the Department gives good augury for the future. I must not omit to mention the labours of my Personal Assistant Mr. Ichhárám Bhagvándás who has rendered me very substantial help during the past year.

I have the honour to be,

Sir,

Your most obedient servant,

G. F. KEATINGE,

Director of Agriculture.

APPENDIX A.

Summary of Experimental Work under the Deputy Director of Agriculture, Presidency.

Cotton.

The principal cottons grown during the year may be classed as under :—

Americans.
Cambodias.
Tree cottons.
Indigenous cottons.
Hybrid cottons.

The Americans are suited to a certain tract of the Southern Marátha Country. Hitherto these cottons have only been experimented with on the Dhárwár Farm, which is not situated in the tract suitable for such cottons. It was therefore decided to rent a piece of land at Gadag and accordingly the most promising American cottons and hybrids were tried there during the year under report.

The season was a poor one owing to the absence of late rains, which provide the major share of the total rainfall to Gadag and neighbouring tálukas situated in the east of the Dhárwár district. Nevertheless these cottons gave a moderate outturn due to careful cultivation both before and after sowing. The same cottons were also grown at Dhárwár where the season was more favourable, but the majority were again, as in previous years, badly affected with "red leaf blight," a disease which makes its appearance when the dry easterly winds blow in the month of December. At Gadag no trace of this disease was sustained, which is a very satisfactory matter. The yields of these cottons were naturally lower at Gadag, but the ginning percentages were higher as will be seen from the following comparative statement which also shows the valuations kindly made by the Bombay Cotton Trades Association :—

Register No.	Name.	Ginning percentage.		Valuation in Rs. per candy of 784 lbs.		Remarks.
		Grown at Dhárwár.	Grown at Gadag.	rown at Dhárwár.	Grown at Gadag.	
...	New Boyd's Prolific (manured).	...	38·95	...	257	Equal to Dhárwár-American.
...	New Boyd's Prolific (unmanured).	...	36·6	...	...	
...	New Allen's Long aple (manured).	...	38·49	...	273	Much superior in class and staple to Dhárwár-American.
...	New Allen's Long Staple (unmanured).	...	37·28	...	...	
212E	Old Boyd's Prolific ...	32·41	36·84	270	259	Dhárwár—Much the same as No. 38E B1. Gadag—Rather better than Dhárwár-American.
209E	King's Improved ...	33·14	35·68	...	...	
211E	Allen's Hybrid ...	33·10	35·03	300 nominal.	270	Dhárwár—Long silky staple, the best of the bunch. Gadag—Staple *much* better than Dhárwár-American.
207E	Truitt ...	32·90	35·03	...	257	Quite equal to Dhárwár-American.
213E	Tata's Allen's Hybrid ...	31·08	33·06	...	...	Disappointing in staple and color.
38EB1	New Orleans ...	29·80	32·56	270	259	Dhárwár—Nice staple and good staple but leafy.
	Dhárwár-American ...	...	30·84	240	257	Dhárwár—"Disappointing in class, color and staple." Gadag—Class much better than No. 47 (which was a sample from a cultivator's field); staple stronger, but not quite so long.

Note I.—"The value of good saw-ginned Dhárwár, *i. e.*, the best class of this cotton free from any admixture, was worth fully Rs. 260 to Rs. 262."

Note II.—The samples valued were not from selected plants, but were of the general picking.

Note III.—Valuations received through the Imperial Cotton Specialist attribute a higher relative value to the last mentioned cotton in the above list grown at Gadag by about Rs. 13.

It will be seen that there is some excellent material upon which to work. Selection for prolificness is not being overlooked, while the figures given above show that a very high ginning percentage is possessed by several varieties. Allen's Hybrid is valued at Rs. 300 per candy and reported to be the best of the bunch. This is Rs. 40 above the best Dhárwár-American-cotton.

The *Cambodias* have also given very promising results in the year under report, as will be seen from the following statement. This variety, which belongs to the same type of cotton as American, possesses the advantage over both Dhárwár-American and New American varieties of being immune to "red leaf blight," and it can therefore be successfully grown on the Dhárwár farm. These cottons are therefore comparable with the Americans, and should be compared with them as regards valuations, etc.

Register No.	Name of variety.	Yield in lbs. of seed cotton per acre.		Ginning percentage.		Valuations.		Remarks.
		Dhárwár.	Gadag.	Dhárwár.	Gadag.	Dhárwár.	Gadag.	
						Rs.	Rs.	
53E	Cambodia from the Philippine Islands.	276	165	34·58	36·82	...	...	Not valued.
66E	Indo-China ...	418	110	33·75	36·94	...	...	Do.
67E	Do. ...	545	130	35·89	37·25	270	260	Dhárwár—Much the same as New Orleans(ante). Gadag—Rather better in staple than Dhárwár-American.
68E	Do. ...	375	116* / 90	35·40	36·83* / 35·20	...	...	
102E	Cambodia from Madras.	524	70	38·43	39·28	...	...	
...	Bengal Buri Cotton ...	228	165	31·09	33·66	280	...	Dháwár—Nice strong staple not so long as Allen's hybrid (ante), but class better, and cotton has more bulk. Gadag—Not valued.

* The first figures show the results on a manured plot, while the second refer to an unmanured plot.

Note.—The valuations received through the Imperial Cotton Specialist assign a higher relative value to No. 67E grown at Dhárwár by about Rs. 15.

It will be seen that the yields at Dhárwár in three instances were very good, while at Gadag the very poor season fully explains the poor yields. The ginning percentages at Gadag especially are excellent, where one cotton attains a percentage of 39·28. At Dhárwár the ginning percentages have fallen off from those obtained last year. The quality of cotton among the Cambodias is much the same, and therefore only one was sent for valuation. The remarks of the Cotton Trade Association about Buri are very encouraging. Its comparatively low yield at Dhárwár was due to the situation of the plot and also to a bad attack of stem-borer which seems to have a liking for this cotton. Cambodia and Buri were both grown at Surat. The former gave the excellent ginning percentage, 40·1 per cent., and yielded up to 385 lbs. of seed cotton per acre. Some of the plants were not vigorous and selection for robust plants was carried out. At Surat, *Buri* cotton did not yield so well as Cambodia, but gave the exceptional ginning percentage of 43·5 per cent. It is likely that great improvement will be effected in the yielding capacity of this cotton by selection of robust and prolific plants. These two cottons were also grown at Dhulia, where the yields were only moderate owing to the absence of good late rains. The valuations however were very encouraging: Cambodia was valued nearly equal to Navsári, while Buri was described as equal to Broach.

Tree cottons.—These are still in the experimental stage but arrangements have now been made to grow the more promising varieties on a large scale, so that an accurate opinion may be formed as to their yielding qualities and also upon the financial aspect of the question. At Dhárwár and Nadiád, Bourbon is the only tree cotton likely to prove profitable, except possibly soft Peruvian. At Surat, there are several foreign cottons of the soft Peruvian and Bourbon types which show promise.

Samples of these cottons have been valued recently and show that the quality of several is very good indeed, as will be seen from the following statement of valuations :—

No.	Register No.	Ginning percentage.		Valuations.			
				By the Chamber of Commerce.		Through the Imperial Cotton Specialist.	
		1907-08.	1908-09.	In Rs. per Candy.	Remarks.	In Rs. per Candy.	Remarks.
1		23·5	30·6	275	"Dull in colour, seedy, but long and strong and silky staple."	300	"Egyptian style."
2	57T (Origin Barbados).	28·9	29·9	350 to 360	"Very long and silky staple, value nominal, Egyptian style."	...	"This sample is of Spence cotton style, but has a weak fibre; were it not for its weak fibre, we should value it at Rs. 400 for its length of staple and silky appearance."
3	64E (Origin Jamaica).	30·0	31·2	360 to 375	"Very long, strong silky, value nominal, Egyptian style."	325	"Egyptian style of cotton."
4	76E (Origin Cuba).	25·2	27·4	340 to 350	"Long and silky staple but rather weak, value nominal; Egyptian style."	315	Do.
5	86E (Origin British Guiana).	24·6	28·	330 to 340	Dull and leafy but long silky staple; value nominal; Egyptian style.	300	Do.
6	78T	31·2	31·05	350 nominal.	"Rather dull and rough but long and strong staple."	315	Same as No. 2.
7	106T (Origin West Indies).	18·9	18·1	400 nominal.	Very long, silky staple; quite like Egyptian.	450	Egyptian style of cotton. The best of the lot.

With regard to Bourbon it was mentioned in last year's report that it appeared to be best suited to medium black soil rather than to black or red soils. A small area of this cotton on medium black soil has now been in existence for three seasons at Dhárwár and the yields per plant obtained each year were as follows :—

Year.	Yield per plant in Tolas.	Percentage of lint.	Remarks.
1906-07 ...	21	26·05	Last year there were 17 plants in all but 2 have since died and hence there were only 15 plants in 1908-09.
1907-08 ...	42	28·27	
1908-09 ...	32	27·54	

Bourbon grown at Nadiád last year with the aid of irrigation grew very vigorously and each plant produced an immense number of bolls which however were small and the ultimate yield was 568 lbs. per acre. The vegetable crop Bhendi was grown between the cotton plants which were six feet apart and the sale proceeds of this crop covered the irrigation expenses which is a most important fact from the point of view of the financial success of this cotton.

Indigenous cottons.—Selection is being pushed forward with the local Deshi cottons at Surat, Dhárwár, Gadag and Dhulia. For it is important that the possibility of greatly improving cotton by selection alone should not be lost sight of in all the work connected with hybridization and trials with exotics. At Surat a specially good plant was observed in the year 1904. Seed was collected from this plant and sown the following year. Since that time plant to plant selection has been carefully carried out every year. In the season under report an area of 7 acres was sown with this cotton and the yield ran from 500 to 600 lbs. per acre with a ginning percentage of 32·5. A selected sample of this cotton was valued at Rs. 275 per candy. During the year under report selection has also been conducted with the object of raising the ginning percentage and an advantage of ·85 per cent. was secured over an unselected sample. At Dhárwár selection for quality in Kumpta has been conducted annually since 1904; the selected seed alone being sown in each succeeding year. The lint is now very soft and fine but this has been secured at the expense of the ginning percentage which has fallen to 23·36 per cent. against 25 per cent.—the normal figure for Kumpta. This is a phenomenon always cropping up in cotton selection, *viz.*, that the quality varies more or less inversely with the quantity within a variety. This cotton gave an excellent outturn in the year under report, *viz.*, 676 lbs. of seed cotton per acre—which has served to minimize any loss sustained from the low ginning percentage. This cotton was valued at Rs. 265 when ordinary farm grown Kumpta was valued at Rs. 248 per candy The best Broach grown on Dhárwár farm was valued at Rs. 270 to Rs. 275 and this gave a ginning percentage of 30·62 to 32·81, so that this cotton is easily the best for the good soils of this locality, provided the late rains do not fail. Selection of prolific plants in Broach grown at Dhárwár has also been carried on every year since 1904-05. The selected variety yielded 522 lbs. per acre and gave a ginning percentage of 29·51 per cent. against 32·81 per cent. of newly imported seed, which proves that, as regards thickness of lint on seed, deterioration has set in.

At Dhulia selection on the lines indicated in last year's report has been continued. It was mentioned that Khándesh cotton consists of a mixture of about half a dozen types and that some of these types yielded a much higher ginning outturn than others. The object is therefore to isolate these best types and increase the seed of them. A small quantity of seed of the best type has been distributed in the present season 1909-10.

At Gadag selection both for quality and quantity in Dhárwár-American as well as in certain of the exotic varieties was commenced in the year under report. It has been found that the fibre of Dhárwár-American ranges from $\frac{3}{8}$ to $\frac{7}{8}$ of an inch (field measurements) and hence there is great scope for selection. Besides this, there are two types found in Dhárwár-American, *viz.*, white-seeded and green-seeded. The fibre of the latter is generally a little longer than that of the white-seeded variety and the ginning percentage is generally better by 1 to 2 per cent.

At Dohad, Khándesh cotton gives promise of success.

Hybrid cottons.—At Surat plant to plant selection has been continued in the case of the more promising crosses while a number of unpromising ones have been rejected. Mention was made in last year's report of the instability of so many of the hybrids as regards quality, and that with the object of obtaining greater control over these variations the "unit system" of selection had been introduced. It is of course too early to report any results with regard to the success or otherwise of this system as it takes at least three or four generations to fix a type and then the area has to be increased, up to at least half an acre, before general conclusions can be drawn.

The best hybrids were again sent for valuation both to the Bombay Cotton Trade Association and to the Imperial Cotton Specialist who referred them to a leading cotton firm for

opinion. In several cases there is a considerable difference between these valuations even if we allow for the fact that the standard of Deshi cotton taken for comparison was higher in one case than in the other. It seems therefore desirable not to place too great dependence on the rupee value assigned to any particular cotton but on the contrary it would seem better to gauge the value of these cottons by their relative positions on the valuation list.

Hybrid No. 1027A, long and fine, which was valued 4th best last year, has regained the first position which it previously held for some years. It was carefully selected last year when fully 50 per cent. of the plants were rejected and seed only of the selected plants was sown during the year under report. The effect has been very beneficial, judged from the valuations of the present year. Three samples were taken (1) from this year's selected plants, (2) from the same plants at the second picking and (3) from the general first picking without selection. These were valued by the Cotton Trade Association at Rs. 280 to 290, 278 and 280 to 290 respectively with Navsári taken at Rs. 285, while the valuations received through the Imperial Cotton Specialist were Rs. 350, 335 and 320 respectively with Navsári taken at Rs. 300 per candy of 784 lbs. The valuations are therefore relatively much higher than they have ever hitherto been. It will be observed that a sample from selected plants is valued at Rs. 30 higher than an unselected sample. The ginning percentage of this cotton is 34·00 in the year under report, which is an improvement of 3·7 per cent. on last year's figure.

Other hybrids valued equal to or above Navsári were:—

Register No.	Valuation in Rs. per Candy of 784 lbs.		Ginning percentage.
	Cotton Trade Association.	Through the Imperial Cotton Specialist.	
1027A Long and Coarse (selected sample).	270	320	33·3
1018 P/9 (unselected sample) ...	272	300	33·3
1018 V/9 (unselected sample) ...	276	300	31·25
Standard Navsári ...	285	300	.....

but it will be seen from the figures that the Cotton Trade Association did not consider these three hybrids superior to the Navsári standard. Six other hybrids were valued above Surti-Broach, the standard of which was put at Rs. 280 by the firm who valued for the Imperial Cotton Specialist, while only two additional hybrids were valued by the Cotton Trade Association as better than Surti-Broach.

It seems not improbable to the writer that the standard prices taken for Navsári and Surti-Broach were too high because samples of cotton which had been collected from some of the best Navsári villages were valued at the following rates:—

Name of village.	Valuations in Rs. per Candy.		Ginning percentages.	Remarks.
	The Cotton Trade Association.	Through the Imperial Cotton Specialist.		
Bhulsad	265	275	33·7	"Rather rough." "Surat style of cotton."
Sisodra	260	270	32·1	"Leafy and staple irregular some a little short." "Surat style of Cotton."
Itarwa	260	265	30·1	"Leafy rather coarse." "Broach style of cotton."
Average	262	270	31·9	

Only three hybrids grown on the Surat Farm were valued below these figures. Hybrid No. 1340, Long and Fine, which topped the valuation list last year was valued at Rs. 285 and described as "Navsári style of cotton but not so soft to the touch." Hybrid 1339, Long and Fine, was valued in the present year at Rs. 270 to 290.

The general conclusion is therefore very encouraging in view of the fact that there were three hybrids grown under the Surat conditions and without selection which were valued equal to or higher than standard Navsári.

Dhárwár, it has been previously stated, is not suitable for American cottons. Hybrids, with an American strain, have therefore been removed to Gadag. These are still undergoing careful selection. Only two of these were valued during the year under report. The best of

these was reported to be worth Rs. 265 per khandi and the remarks of the Cotton Trade Association were "superfine class, much higher than Dhárwár-American staple, rather short, and irregular." This was a hybrid between Christopher (male) and Dhárwár-American (female). A sample of Dhárwár-American from a cultivator's field was valued at Rs. 250 on the same day. Four Herbaceum crosses were imported from Surat and grown for the first time at Dhárwár. These yielded well and gave a fairly satisfactory ginning percentage. Their valuations are also good, as will be seen from the following statement:—

Register No.	Cross.	Number of plot.	Area in gunthas.	Yield per acre in lbs.	Ginning per-centage.	Valuation in rupees per candy of 784 lbs.	Remarks.
1027A L. and F.	Kumpta + Ghogari.	384	5·7	203	31·09	270	"Equal to Broach."
1027A L. and F.	Do. ...	386	5·7	329	30·12	...	
1339 L. and F.	Kumpta + Kumpta recrossed.	133—141	36	624	27·18	265	"Decidedly better than ordinary Kumpta but lower than Broach."
Do.	Do. ...	...	41	198	...	...	
1340 L. and F.	Do. ...	133—141	20	774	28·85	270	
Do.	Do. ...	912	37·5	593	30·40	...	
1340 L. and C.	Do. ...	912	50	566	30·10	273	"Slightly better than Broach."

Note.—Valuations obtained from the Imperial Cotton Specialist assign a higher relative value to the first mentioned cotton.

Hybridization has been continued during the past few seasons and rigid selection on the lines of the "Unit system" is being carefully carried out.

At Nadiád there are several excellent crosses between American (Texas) and Bourbon and also between Egyptian and Sea Island and Bourbon; but the first mentioned American crosses are the most promising as will be seen from the following summary. The objection to pure Bourbon has been the defective opening of its bolls which causes weakness in the fibre. It was with the object of removing this defect that these crosses were made and it has been found that the American crosses all open well, while most of the Egyptian and all of the Sea Island crosses do not open properly; however one Egyptian cross, *viz.* 1380, opens much better than any of the other Egyptian crosses.

Register No.	Name of Hybrid.	Area grown in 1908-09 in gunthas.	Ginning per-centage.	Yield per acre in lbs. of seed cotton.	Valuations.			
					The Bombay Cotton Trade Association.		Through the Imperial Cotton Specialist.	
					Value in rupees per candy of 784 lbs.	Remarks.	Value in rupees per candy of 784 lbs.	Remarks.
1371	Texas + Bourbon (35T) ...	10	24·2	753	260	"Rather dull in colour, nice staple."	300	"Navsari style of cotton."
1370	Texas + Bourbon (23T) ...	10	26·2	698	260	"Dull and stained but nice staple."	260	Do.
1368	Texas + Bourbon (15T) ...	10	...	705	...	Not valued ...	...	Not valued.
1367	Texas + Bourbon (13T) ...	10	...	1,114	...	Do. ...	...	Do.
1380	Abassi + Bourbon (21T).	5	26·5	216	265	Dull colour but very nice staple.	350	"Egyptian style."

It will be seen that the American hybrids have given fairly good yields, especially No. 1367. Three irrigations were given to the crop but the expenditure on this account was recovered by growing a crop of Bhendi between the cotton plants.

At Dhulia a few hybrids are being carefully selected and a large number of new crosses were made during the year. These were made between neglectum types with the object of trying to combine the good quality possessed by some with the high ginning percentage possessed by others.

A number of new crosses between Cambodia varieties *inter se* have been obtained in the present season with the object of increasing the vigour of these varieties. A few new Herbaceum crosses have also been obtained.

Mendelism.—Investigations on this subject with regard to cotton have been continued during the past year both at Dhárwár and Surat. It has frequently been asserted that such characters as the colour of the flower are mendelian characters and that red is dominant over yellow. The evidence in support of this contention has not always been very convincing. Work done at Surat by my predecessor and subsequently at Surat and Dhárwár has undoubtedly shown that in the majority of cases red does appear to be dominant over yellow and yellow over white, but there have been apparent exceptions to this rule, as for example in

the season under report 17 crosses out of 343 between Harbaceum (yellow male) and Arboreum (red female) have resulted in yellow flowered offspring in the (F.) first generation; while twin plants, *i. e.*, plants raised from other seeds from the same bolls, have produced red flowers. Another pair of characters which have been chosen for the purpose of this investigation are "free seeded" and "chain seeded." Thus rough Peruvian produces bolls in which the seeds are free while kidney cotton produces bolls in which the seeds are joined together. The practical outcome of such inquiries is of course to ascertain whether the good qualities possessed by two varieties can systematically be united in some of their offspring together with the elimination of their bad characters, *e.g.*, prolificness and high quality of fibre.

Careful records of the other pairs of characters have also been made but for the sake of simplifying the work the characters mentioned have been specially chosen for this investigation.

These experiments are fully described in the Surat and Dhárwár annual reports for the year 1908-09.

Wheat.

This important crop deserves greater attention than it has been found possible in past years to bestow upon it. In the year under report attention has been paid to wheat at the following farms: Dhárwár, Dhulia, Nadiád and Dohad. The work may be summarized under the following heads: —

(1) Collection of samples from all wheat-growing tálukas, growing the seed on Government farms and analysing the produce according to Professor Gammie's classification.

(2) Selection both collectively and individually, with the object of increasing the yield per acre of the principal Bombay wheats. The following characters received special attention: (*a*) Number of spikelets in a head, (*b*) tillering capacity, and (*c*) rust resistance.

(3) Trial of new wheats both of Indian and foreign origin.

The first of these items constitutes a survey which is being made of the wheats of Bombay. Apart from the work of analysing the samples into the types laid down by Professor Gammie, general information with regard to soil, cultivation, etc., etc., has been collected through the assistance of the Revenue Department and it is intended to publish the results of this inquiry in a separate report.

With regard to the second division of the work, *viz.*, selection with the ultimate object of increasing the yield per acre of the principal local wheats, it seems necessary to pay greater attention to this aspect of wheat improvement than to quality, important though this latter character undoubtedly is. The trade recognizes as the chief distinguishing characters of wheat the following: (*a*) hardness and softness, and (*b*) red, yellow and white coloured grains. One of the (*a*) characters is, of course, always associated with one of the (*b*) characters, as for example hard yellow, which appears to be the favourite wheat for export. Having fixed the variety according to the above characters the prices for well-matured and developed samples within a variety do not appear to differ to any great extent and hence the reason why it is more important to attend to quantity at the outset of work devoted to wheat improvement. It is well-known that the yield per acre in India compares extremely badly with that obtained in England and there is indeed very great scope for an improvement in this respect. The aforesaid remarks assume that we are dealing with a pure sample, a thing which seldom is the case with cultivators' wheat. It is a recognized practice with wheat merchants when buying, say, white wheat to allow for a high percentage of red and an admixture of barley also. The first thing to give the cultivator therefore is a pure sample of what he himself is growing and after that the next work to be done is to effect an increase in the outturn per acre.

Selection is therefore being done both collectively and individually, *i. e.*, when a specially good plant is found its seed is harvested separately and sown alone in the following year. At Dhárwár in the season under report one plant was found with 17 spikelets holding 79 grains. It will be interesting to see whether the offspring do equally well.

With regard to the 3rd division of the work, *viz.*, the trial of new varieties, this is really a development of the previous one because its object is to ascertain whether an improvement either in yield or quality can be secured by substituting a new variety for the present existing Deshi varieties. Shet Párner obtained from Mánjri appears to be a very superior wheat and this will be extensively grown in the next season. One of the Punjab-Australian wheats, *viz.* No. 27, produces very fine ear heads. The results obtained in the present season indicate that a few of these new wheats will probably be found to be well worth substituting for some of the Deshi varieties.

Hybridization was carried on to a small extent at Dhulia and crosses between the local varieties of Mundi and Bansi with Khapli (spelt wheat) were made with the object of getting a rust-resisting hybrid. Khapli wheat is practically immune to rust.

Jowár.

Little has been done in the past to improve this valuable staple crop. At Surat for the past two seasons careful selection has been in progress in the case of the three best Gujarát varieties, *viz.*, Chapti, Perio, and Sholápuri. This has been conducted on the "unit system," *i. e.*, individual superior plants have been selected and their seed propagated separately. It is of course too early to report any definite conclusions but this is a line of work which promises to give excellent results. Apart from the special selection, the best heads are always chosen on the threshing floor and this seed is used for the general farm sowings.

In Khándesh where the season is a short one, jowár is handicapped in comparison with bájri. An experiment was conducted in the year under report in which two new varieties were tested against the local (Mothi) variety. The following statement shows the results :—

Area of plot in gunthas.	Variety of jowár.	Yield in lbs. per acre.			Cost of production per acre in rupees.	Value of produce per acre in rupees.	Net profit per acre in rupees.
		Grain.	Kadbi.	Chaff.			
					Rs. a. p.	Rs. a. p	Rs. a. p.
10	Mothi ...	468	2,160	84	18 12 2	31 3 4	+12 7 2
27	Gudghi ...	1,000	4,311	43	18 6 5	61 12 6	+43 6 1
16	Bilaspur ...	352	1,975	30	25 0 4	24 11 2	— 0 5 2

Gudghi jowár is hardy and ripens a month earlier than the other two varieties. This is a very important point in a district where the rainfall is short. This variety therefore seems to be well worth growing in the Khándesh District.

Hybridization on a small scale has been commenced but in the year under report the season was unfavourable for making crosses at Dhulia.

Investigations, so far as they have gone, indicate that natural cross fertilization which is so common with bájri does not take place in the case of jowári.

Tur (Cajanus indicus).

A number of Indian varieties were grown at Surat and Dhárwár with the object of ascertaining whether any of these possess superiority over the Deshi variety. At Surat the local variety is a very good one and is apparently superior to most of the other varieties tried. However Sambalpur, Bilaspur and Bangalore are all superior varieties and in regard to bushiness and branching capacity and also in the size of the pods and grain these varieties surpass the Deshi varieties of Dhárwár and Surat. Accordingly a few crosses were made between these varieties and the local variety in the year under report. At Dhárwár an effort was made to separate different types from several varieties including local and those from Bilaspur, Bangalore, Sambalpur and Nadiád. Next year observations will be made to see whether any good characters are correlated with special types.

At Nadiád also from the local variety different types have been separated to see whether these have fixed characters or vary from season to season.

Groundnuts.

Several varieties of this crop were grown at Surat, Dhárwár, Dhulia and Dohad during the year under report.

At Surat the season was favourable to dry-crop groundnuts, and Spanish peanuts gave a yield of 1,433 lbs. per acre while Japanese Small yielded 1,074 lbs. A substantial net profit was left in each case in spite of the heavy cultivation charges. The cost of production amounted to Rs. 69-6-10 per acre, of which more than half went in harvesting expenses. The same varieties were grown as a mixed crop in alternate rows with both cotton and jowár. In the case of the cotton plot, Spanish peanut yielded at the rate of 1,103 lbs. per acre, and cotton gave 402 lbs. of kapas so that the gross value of the crop was Rs. 123-9-2 and the nett value Rs. 77-13-0. In the case of the jowár plot, the groundnut crop yielded 599 lbs. and the jowár 1,429 lbs. per acre worth Rs. 108-11-4 and left a net profit of Rs. 58-5-10.

For the last 4 years several varieties have been grown with the aid of irrigation ; the best yields on the average have been :—

Mozambique	...	2,987 lbs. of unhusked nuts per acre.
Virginia	...	2,874 do. do.
Senegal	...	2,823 do. do.

while in the present season the most prolific yields were :—

Virginia	...	3,975 lbs. per acre.
Chinese No. II	...	3,965 do.
Mozambique	...	3,882 do.

But it is important to point out that the yield of unhusked nuts is not the only thing to take into consideration. There is also the percentage of kernel to unhusked nuts and of oil to kernel to be reckoned with. If we wish to know which have yielded the greatest quantity of oil per acre on the average we find that after taking all factors into consideration the following is the order of merit :—

Virginia with 1,040·39 lbs. of oil per acre.
Mozambique 958·96 do.
Japanese Large 900·90 do.

while local has only given 693·38 lbs. of oil per acre on the average of 4 years.

At Dhulia, Virginia and Japanese Large have done best as irrigated crops, leaving a net profit of Rs. 61 and Rs. 55 respectively, while Spanish peanut has proved an excellent dry-crop variety even for Khándesh where the season is short. The present season however was very favourable and the yield obtained was 1,501 lbs. of dry unhusked nuts per acre, leaving a gross profit of Rs. 114-7-0, of which Rs. 34-9-0 were net profit.

At Dohad, in spite of an unfavourable season, the yield was good. Japanese Large and Spanish peanut grown as dry crops without irrigation yielded at the rate of 2,245 lbs. and 1,710 lbs. of unhusked nuts per acre. The value of the Japanese Large crop was Rs. 174-2-9 but the cost of cultivation was very high, *viz.* Rs. 118-0-6, due to the heavy cost of digging out the nuts in a soil which sets hard after the rains. This item alone amounted to Rs. 61-6-6.

At Dhárwár, the season is a comparatively long one and therefore suitable for dry-crop groundnuts. In the year under report the season was fairly good. The best yields were obtained from the following varieties grown without irrigation :—

Mozambique	...	2,390 lbs. of dry unhusked nuts per acre.	
Senegal (New seed)	...	2,072	do. do.
Pondicherry	...	2,017	do. do.
*Egyptian	...	1,930	do. do.

But if we look at the oil yield the order of merit is changed as follows :—

Senegal (New seed)	...	914·5 lbs. of oil per acre.
Mozambique	...	864 do.
Egyptian	...	810 do.
Pondicherry	...	785 do.

The reversal of the first and second positions is an interesting fact and is due (1) to the thicker shell of the Mozambique and (2) to the very high oil percentage, *viz.* 57·12, possessed by Senegal.

Selection is in progress on the Dhárwár Farm to obtain early maturity. It was observed in the year under report that the plants from selected seed ripened a little earlier than the rest and in doing so escaped Ticca disease, which slightly attacked the general crop at the close of the season. The percentage of oil, however, appeared to be diminished by the early maturity.

Til.

Several varieties were grown on the Dhárwár, Nadiád and Dhulia Farms during the year under report with the object of ascertaining the best agricultural variety. Samples of all varieties were kindly analysed by the Agricultural Chemist with the following results :—

Name of Farm.	Name of variety.	Percentage of oil.	Percentage of moisture.
Dhárwár	(1) White Kánara ...	57·03	Figures not available.
	(2) White Ahmednagar ...	56·89	
	(3) Dhárwár Local ...	55·22	
	(4) Surati ...	54·74	
Dhulia	(1) Háveri Til ...	63·23	3·85
	(2) Dhárwár ...	56·68	2·78
	(3) Kathli ...	49·48	3·85
	(4) White Kánara ...	44·87	4·29
Nadiád	(1) White Local ...	53·01	4·10
	(2) White Sholápur ...	50·83	4·10
	(3) Black Local ...	50·30	4·21
	(4) White Ahmednagar ...	49·24	3·49
	(5) White Kánara ...	47·30	3·66

* Both Tumbo seed and Chinese No. I yielded slightly better than Egyptian, but lost ground in oil percentage owing to the high husk percentages.

It will be observed that the Háveri Til grown at Dhulia has an exceptionally high percentage of oil. Seed of this variety has been sown in the current year (1909-10) on the other farms and it will be interesting to see whether it maintains its high quality.

Castors.

A large number of castors have been grown during the year under report at Dhárwár and Surat for the purpose of studying their agricultural and botanical characters. Samples of these have been analysed by the Agricultural Chemist. The following varieties show the best analyses :—

Name of Farm.	Name of variety.	Percentage of oil.	Percentage of moisture.
Dhárwár	(1) Chitta Audla Athani ...	58·82	5·10
	(2) Liye Ahmedabad ...	53·54	4·46
	(3) Paras Diveli (19*a*) ...	50·87	3·92
	(4) Do. (19*b*) ...	50·75	5·10
	(5) Small Ahmedabad ...	50·73	4·66
	(6) Diveli Dindori (25A(*a*)) ...	50·59	5·16
Surat	(1) Nimar No. I ...	54·29	3·90
	(2) Nimar No. II ...	52·69	3·36
	(3) Dewela Chani, Kaira ...	52·81	5·49
	(4) Small Sholápur ...	52·75	3·24
	(5) Madras No. IV ...	52·70	4·24
	(6) Liye Surat No. VI ...	52·47	4·31
	(7) Paras Dewela Kaira ...	52·09	5·19

It appears that the oil content varies a good deal. The lowest percentage of all the samples sent was 44·10 per cent. which was of a sample of a white variety grown from seed received from Indápur. It is proposed to extend the area of the more promising varieties to ascertain their relative prolificness.

Tobacco.

Experiment in shade growing.—It has frequently been observed that tobacco grown on the Nadiád farm from Deshi seed produced very thick resinous leaves and this is indeed a characteristic of the tobacco produced in the Charotar villages of Northern Gujarát. Some years ago seed of the famous wrapper producing tobaccoes was obtained from Sumatra and elsewhere with the object of seeing whether these tobaccoes would retain their high qualities when grown under the condtions which prevail in Gujarát. The varieties obtained and tested included :—

Talaen	Java D.
Havanah	Florida.
Java P.	Sumatra.

These have now been grown for some years past and they all seem to suit the country from a purely agricultural point of view, but it was seen from the beginning that they were not retaining their reputation for producing leaves of thin texture and mild flavour; on the contrary they have gradually acquired the character of Deshi tobacco referred to above. This is not at all surprising when it is pointed out that Nadiád has a sandy-loam soil where there is a very strong sun during the latter part of the growing season when the air becomes very dry. It was therefore thought desirable to experiment with shade grown tobacco and see whether a leaf of thin texture and mild flavour could be produced in the same way as is done in some parts of America. Accordingly an area of 2 gunthas was measured off and a temperary erection made of bamboo poles was put up. This at a height of 9 feet above ground level was covered over with white cotton cloth and the sides were also covered down to the ground at a cost of Rs. 124-8-6; most of the material will be again available for use next season. Florida and Sumatra varieties were selected for trial in the experiment and each of these was sown on one guntha. It soon became obvious that one effect of the shade would be to make the plants grow very much faster and attain a very much greater height than those grown in the open which were growing close at hand for comparative purposes. The plants were intentionally not topped to allow them to produce a large number of leaves with the object of these being less well nourished and therefore thinner in texture and milder. Very little suckering was required as the plants did not produce many suckers. The tallest Florida plant attained a height of 8 feet 9 inches and produced 27 leaves, while the tallest Sumatra plant produced 26 leaves and grew 7 feet and 8½ inches in height. The tallest plant of Sumatra grown in the open and not topped reached a height of 4½ feet and produced 13 leaves, while the tallest Florida plant grown in the open stood 5 feet 2½ inches high and produced 14 leaves.

The crop grown under shade was not watered because it was found that irrigation tended to make these tall delicate plants fall over. The crop grown in the open was watered three times as usual. All the tobacco was planted at the same time in August during the rains.

The yields of cured leaf produced were at the following rates per acre in lbs.:—

	Florida.	Sumatra.
Shade	680	840
Open	1,200	1,120

The yields of shade grown tobacco in America is said to be about 800 lbs. per acre. The shade grown leaf was extremely thin and papery to the feel. The leaf was dried in the tobacco barn where it was found that the shade grown article took a couple of days longer to dry than that produced in the open, which dried in a week. Owing to difficulties in regulating the humidity and temperature, the shade grown leaf became very brittle and difficult to handle, whereas it ought to be very elastic and steps are now being taken to overcome these difficulties.

The Curing Barn.—The farm grown tobacco was again cured in the new barn erected for the purpose last year. Considerable difficulty was experienced in regulating the temperature and humidity, but steps are being taken in the current year to get over these difficulties. Samples of the cured leaf have been sent to the Imperial Institute, London, for opinion and valuation and also to the Rangpur Tobacco Company.

Selection was made last year of plants possessing certain types of leaves to see whether these were permanent characters. It is important in tobacco intended for wrapper purposes that the large veins should be arranged parallel to one another and at regular intervals along the midrib. This was found not to be so in the case of the veinings.

Potatoes.

This is a very important crop in the neighbourhoods of Belgaum and Dhárwár. The Department have rented a plot of 5 acres at Belgaum and the first crop was taken during the year under report. The local cultivators always purchase Italian seed for sowing at Belgaum and the produce of this is sown at Dhárwár. Seed cannot be retained from one season to another owing to insect attacks in the stores which are not well protected.

With the object of ascertaining whether Italian seed is the best for the purpose, a large number of varieties obtained from different parts of India and also from some of the famous European Potato districts, were grown on small plots and the following statement comprises those varieties which gave the best outturns :—

Name of variety.	Register No.	Yield per acre in lbs.
Duke of Cornwall	79	33,142
Northern Star	52*c*	32,800
Early Rose	21*c*	23,746
Suttons Superlative	73	23,520
Windsor Castle	75	22,154
Hymalian Old	54*a*	23,000
Burbank	92	20,470
Scotch Champion	84	20,000

Besides these a large number have yielded over 10,000 lbs. per acre. It will be seen that the highest yield amounted to about 15 tons per acre which must be considered very satisfactory.

Italian yielded 12,811 lbs. which was considerably less than a large number of other varieties. If these results are confirmed this year, it will be a matter for careful consideration whether some of the best yielding varieties should not be distributed to cultivators and the latter recommended not to grow the Italian variety.

There are however other factors which have unfortunately to be taken into account, *viz.*, (*a*) insect attack and (*b*) rot. Many of these varieties are specially subject to rot; Lachmari which yielded a crop of 15,756 lbs. per acre was the first to become affected with rot which occurred only a fortnight after the crop was harvested. The English varieties also followed suit a little later, but these are more resistant to insect attack in the godowns. It has been frequently observed that varieties with deeply set eyes are most subject to insect attack and this observation was again confirmed in the year under report. Most of the English varieties have shallow eyes. Investigations will therefore have to be continued till a good yielding variety, resistant to rot and insect attack, has been found.

At Belgaum potatoes are grown as a rabi crop with the aid of irrigation, while at Dhárwár they are grown as a rain crop without irrigation. In the year under report potatoes were grown in black soil (the farm site) and in red soil (Kelgeri site). The produce of the crops

grown on these two soils was kept separately until it was required for sowing at Belgaum in the rabi season. It was at this time that it was discovered that the potatoes produced in black soil had begun to rot very rapidly and were also attacked by insects, while the crop produced in red soil was in sound condition.

An effort was made to introduce this crop upon the Dohad Farm in the year under report and with fair success. It was necessary to sow the seed with only a limited quantity (5 tons per acre) of farmyard manure and on land not previously cultivated for such crops. Fresh Italian seed was used and an outturn of 8,652 lbs. per acre was obtained. The brown loams found in the Panch Mahâls are likely to suit this crop well where sufficient manure can be obtained along with irrigational facilities.

Tapioca (Manihot utilissima).

The crop has the reputation of providing a cheap famine food in years of scarcity. At the request of the Director of Agriculture it was tried on all farms under my charge. There are two principal ways of utilising the produce—(*a*) by slicing the tubers and selling the dried slices for consumption and (*b*) by extracting starch from the tubers. In the latter case the crop should remain about 18 months in the soil by which time the tubers become too fibrous for the first mentioned purpose for which they should be dug up when about 8 months old.

At Nadiád the crop was planted in a sandy loam soil in the month of August. The plants grew well. In May 1909, the tubers were dug out. No manure was given, but the crop was once irrigated which was probably unnecessary. The average yield per plant was 3½ lbs. of green tubers, while the best plant gave 9¼ lbs. The dry weight was about ⅓ of the green weight. If we take the yield per acre, the outturn was at the rate of 4,000 lbs. (green) per acre.

At Dohad the crop was planted on an area of ½ an acre in the beginning of July 1908. There were a number of blanks owing to the cuttings being rather too small, but apart from this the crop grew well, until the end of December when frost did a good deal of damage. In May 1909, the tubers were dug out, cut into slices and sun dried. The green weight per acre was 494 lbs. and the dry weight 172 lbs.

At Surat the crop was planted on the 13th July on an area of ¼th of an acre, but many cuttings did not strike root owing to unfavourable weather. Only 158 plants ultimately bore tubers. These were dug out on the 11th May and the average weight of green tubers per plant was 2 lbs. 9 ozs. green, while the dry weight was 9 ozs. per plant. The tubers were cut into slices and sun-dried. The soil was a moderately deep black cotton one which cracks very much in the hot weather. This crop was irrigated once.

At Dhulia the plants were established on medium black soil in the month of July 1908 on a plot of 5·6 gunthas. The crop grew well and remained healthy. The tubers were lifted in July 1909, and the yield per acre was 771·4 lbs. and per plant 1 lb.

At Dhárwár the crop was planted in fairly deep black soil in August last and it has grown vigourously. It is proposed to keep the crop for 18 months from the time of planting before lifting the tubers.

Summing up it appears that each plant has produced from ½ to 1 lb. of dry tubers. If this year's results can be accepted as reliable, this would work out at a yield of about 907·5 lbs. of dry tubers per acre (the plants are 6 feet apart either way) which seems to be too small to be profitable. The experiments will be repeated next year, but it seems improbable that the crop will do well on heavy black soils. There were two kinds of tubers, *viz.*, white and red; the latter is said to be sweeter than the former.

Canaigre (Rumex hymenosepalus).

This crop has been grown on a small scale at Dhárwár for the past two seasons. It produces tubers which contain a considerable amount of tannin, which is used for dyeing purposes in North America—the home of this plant—where the average percentage of tannin is 23 per cent. Last year samples were sent to the Reporter on Economic Products for opinion and he found it to contain 12·5 per cent. of tannin; samples were again sent in the season under report and the tannin percentage has risen to 20·4 per cent. The Reporter on Economic Products pointed out last year that to be successful in this country the root would have to be placed on the market in a dried state at rates not higher than those of babul bark and myrabolams. It is proposed to extend the area of this crop in the coming year.

Miscellaneous Crops.

Experiments have also been conducted with sugar-beet, linseed, Rhea, jute, Berseem, various Assam pulses and melons, but the results hitherto obtained call for no special remarks at present.

Tillage and Cultural Experiments.

Deep versus *shallow cultivation.*—At Surat experiments have been conducted for the pase 4 years to test the effects of deep ploughing for cotton and jowár on black cotton soils. Thf results for this period show that deep ploughing is beneficial for jowár, while in the case ot cotton shallow cultivation has proved better until the present year. The reason why deep ploughing for cotton has hitherto not been a success may be due to the fact that the ploughing was always done after the rains broke so that the land had not time to settle down before the

seed was sown. Now cotton does not germinate well if the seed falls deep as it probably would do under these conditions. In the present season the ploughing was done on the 4th July, but owing to continuous heavy rains the seed could not be sown till the end of that month by which time the soil had settled down into position and the germination of cotton was observed to be good. A new experiment is now in progress in which the land is ploughed as soon after the previous harvest as possible. At Nadiád deep ploughing has given uniformly better results with the tobacco crop. With kharif crops it proves successful when the sowing is not delayed, but there is a danger, in this part of the country where the rains have been badly distributed for several years past, of losing a favourable opportunity for sowing by devoting time to deep ploughing and it is most important in this district to get the seed into the land at the very first opportunity. At Dhulia deep ploughing for cotton gave good results. But the end of the season was unfavourable to the crop owing to the absence of late rains.

In this section mention should be made of the very high yields of gram which were obtained at Dohad. This was due to the practice of sound agricultural methods—sometimes referred to as "dry farming" in American and Australian publications as a new invention—in conserving the monsoon moisture. This was effected in the following way :—A crop of maize had been sown on a block of 18 plots with the object of ascertaining their relative fertility. The maize crop, however, was greatly damaged by the continuous rains which fell in the months of July and August and it was seen that the outturn would be of no value for comparative purposes. The crop was therefore removed in the month of September and the land ploughed up. This enabled the area to be thoroughly cleaned by repeated weedings and harrowings. The land was kept constantly stirred by alternate ploughing (with country plough) and summaring so that a good mulch of surface soil was obtained; this was continued until the middle of October when gram was sown throughout the whole area. It should be noted that after the end of August only 63 cents of rain fell, of which 49 cents came in the first fortnight of September and the rest in the latter part of the same month. The yields obtained on these plots ranged up to 2,185 lbs. of gram per acre. The crop was not irrigated and the land had not been manured since it was taken possession of by the Department.

Spacing and thinning.—Experiments at Dhárwár on black soil indicate that the best arrangement for jowár is a 12″ drill followed by thinning in the row so as to leave an interval of 6 inches between consecutive plants. A plot treated in this way during the year under report with the aid of 2 tons of farmyard manure per acre yielded at the rate of 2,491 lbs. of grain per acre in addition to 5,480 lbs. of kadbi and 455 lbs. of chaff. The variety was fulgar yellow. In the case of cotton a 24″ drill seems to give a better outturn than the 18″ one which is usually used by the Dhárwár cultivator. Thinning to a distance of 18 inches in the row has further increased the outturn.

At Surat the drills of 24″, 30″ and 32″ for cotton have given the best results, while thinning in the row to a distance of 24 inches between consecutive plants gave the best results. Compared with Dhárwár it should be remembered that Broach cotton is a more bushy plant than Kumpta.

At Nadiád, Bájri, Bájro, Kodra and Sundhia jowár have all given better outturns when drilled at 18″ instead of 12″ between the rows.

Manurial Expriments.

Trials were made on all farms with various bulky and artificial manures with the object of finding an economical substitute for or supplement to farmyard manure.

Artificial manures such as Sodium Nitrate have greatly increased the cutturns of cotton, jowár, and til at Surat, but at present prices these manures do not compare favourably with farmyard manure. Of cake manures, castor has given good results on the same crops, but even this is too dear to seriously compete with farmyard manure. Poudrette applied in 1904, still continues to greatly benefit the jowár and cotton crops at Surat. In the case of jowár the average net profit is Rs. 54-7-7 per acre, while in the case of cotton the average net profit is Rs. 33 per acre throughout the whole period of 5 years. The striking feature about the jowár plot manured with poudrette is the great vegetative growth produced; thus in addition to grain, the poudrette plots have yielded on the average 4,500 to 5,000 lbs. of kadbi per acre against 2,000 to 3,000 yielded by the farmyard manured plots. An interesting feature brought to light at Surat is the excellent crops which can be obtained from black cotton soil without the aid of manure if only the land be kept clean and well tilled. On two plots, *viz.* 388 and 389, no manure has been applied since the land was taken up in 1896 and probably for long before that, yet these plots have produced an average outturn of 310 lbs. of seed cotton per acre, while similarly treated plots, *viz.* 413 and 414, have produced an average yield of 925 lbs. of jowár per acre. All the plots were sown in alternate years with cotton and jowár.

Rotational Experiments

Rotations are being investigated at Dhárwár, Dhulia and Nadiád. At the first place there are no definite conclusions to be reported yet. At Dhulia special attention is being paid to finding out the most profitable rotation in which to grow cotton, as this is much the most important crop in Khándesh occupying ⅔ths of the cultivated area. In the year under report cotton grown on a plot, which was fallow last year, was much more vigorous than the crop on other plots which produced bájri, til, &c., last year. It also remained green longer and continued to yield after the other plots had ceased to produce any kapás. This fallow-cotton

rotation however is not a profitable one compared with til-cotton and bájri-cotton. The general conclusion to be drawn from this and previous year's results is that the til-cotton two year rotation is the most profitable one, while bájri cotton is very nearly as good. The average annual net profit from the former has been Rs. 35-12-11 per acre and from the latter Rs. 30-12-3 per acre. It is a common practice in Khándesh to take cotton continuously for several years on end. The average net profit per acre on the Dhulia farm has been Rs. 16-13-10.

At Nadiád the local practice is to grow several crops mixed. Experiments are in progress testing this practice against the same crops grown singly. Probably the object of the former practice is for the purpose of serving as an insurance against the precarious seasons when some crops entirely fail and other grow well.

Irrigational Experiments.

The experiments in irrigating cotton on black cotton soil at Surat were continued and the results obtained again emphasize the greatly increased profits which could be obtained if only cheap irrigational facilities existed. The yield was increased by 20 and 50 per cent. on the plots twice irrigated. The cost of raising the water out of a well however does not admit of any increased profit in spite of the greatly increased yields. It was mentioned in last year's report that the chief objection to irrigating heavy black cotton soil would probably be the injurious effect upon the texture of the soil caused by continual and excessive irrigations. Some information on this point was obtained in the year under report. A plot of land had been under lucerne for between 3 and 4 years during which time it had been continuously irrigated at short intervals except during the monsoons. The total water applied must therefore have not been less than 435,600 cubic feet per acre. Yet the lucerne was ploughed up in the month of April 1908 and the land sown with Broach cotton in July of that year. The outturn of seed cotton was at the rate of 583 lbs. per acre so that the soil seems to be still capable of producing a good crop of cotton.

Miscellaneous Experiments.

Experiments are in progress at Surat, Dhárwár and Dohad in which farm selected seed is being compared with bazar seed. At Surat the experiment was conducted on a large scale, with the result that jowár grown from farm selected seed yielded at the rate of 1,138 lbs. per acre, while the crop raised from bazar seed yielded 938 lbs. per acre or a difference of 200 lbs. per acre which represents a gain of 20 per cent. At Dohad the trial was conducted with maize. Each sample was sown on one-fourth of an acre and in a veay unfavourable season a gain of 193 lbs. per acre was secured, the yields being bazar seed 663 lbs. and farm selected seed 856 lbs. per acre. At Dhárwár the experiment was conducted with cotton, but the result was vitiated through the previous cropping of the site part of which grew cotton last year.

An experiment is being conducted at Surat to investigate the proper time for sowing cotton. In the year under report a late sown plot in September yielded better than other plots sown in July and August. This has been suggested to me to be due to the tillage operations being more effective in conserving moisture on an unsown plot than after the seed has been sown which admits of cultivation between the rows only and not over the whole surface. Another experiment conducted at Surat with cotton was sowing the seed before the rains, but no definite conclusion has been arrived at.

Trials with new Implements.

Trials continue to be made on several of the farms under my charge with new implements and machines. In the year under report a Japanese gin driven by foot power has given excellent results. A man and a small boy can gin 250 lbs. of seed cotton in a day of 8 hours with this machine. A double mould board plough has proved very useful for making furrows for sowing the potato plot and cultivators near the Dhárwár farm have begun to borrow this implement. Of the implements and machines previously introduced the Cawnpore chain pump continues to find great favour and the difficulty is to meet the demand for these machines.

Seed Distribution.

The following statement summarizes the principal seed distribution during the year:—

Name of centre.	Quantity of seed in lbs.				
	Cotton.	Jowár.	Ground-nut.	Potatoes.	Maize.
Dhárwár* ...	Broach 18,255 Kumta 9,820 Dhárwár-American 103	1,051	1,672	178	...
Surat ...	8,374	1,570	2,166	...	...
Nadiád ...	158	16,720	...	...	...
Dohad ...	.....	...	48	40	307
Dhulia ...	1,957	43	957	...	1

* NOTE—In addition to the above over 9,000 lbs. of selected Dhárwár-American cotton seed was supplied to the Punjab Government.

At Surat 1,500 lbs. of Hybrid No. 1018 P/C were distributed to a few villages near the Farm. The cultivators who sowed the seed have benefited very substantially for, apart from getting good seed, they secured a much higher price for their Kapás than for the Deshi Kapás. The price at which they sold the Hybrid Kapás was Rs. 106 per bhár of 960 lbs., when the Deshi Kapás was selling for Rs. 101 per bhár. The local merchants appreciate the better quality of the Kapás and express their willingness to pay higher for all Kapás grown from Farm distributed seed. The effect of these prices has been to greatly increase the demand for seed in the present sowing season (1908-09) so much so that the demand cannot be met. It is not certain yet whether the increased price amounts to the fully increased value of the Kapás but it is a very substantial amount and more than sufficient to induce cultivators to abandon their own seed for that supplied by the Farm.

Reference was made in last year's report to the successful introduction of the Broach variety into the Southern Maratha Country. This work has been continued during the year under report. An important factor affecting the success of this work came to light during the past season. The late rains in the Dhárwár District were deficient and many of the cultivators complained that under these circumstances Broach cotton gave them less outturn per acre than Deshi Kumpta. It was therefore feared that this would materially affect the area sown with Broach cotton in the coming season (1909-10) but fortunately this has not been the case. The Department again organised an auction sale at Dhárwár and cultivators showed their confidence in the Department by sending in their cotton to be sold at this auction. As was the case last year very remunerative prices were obtained and 288 nágas out of 309 were sold at prices ranging from Rs. 150 to Rs. 174 per nága (1,344 lbs.). The price of Kumpta cotton on the same day in the Hubli market was Rs. 116 per nága. The effect of this auction had a reassuring effect on the minds of cultivators and a large quantity of Broach seed has again been distributed for sowing in 1909-10. It has been observed that Broach cotton after it has been grown continuously for a few years in the Southern Maratha Country deteriorates in ginning percentage and hence it is necessary to import fresh seed periodically from Gujarát. This fact has been brought to the notice of cultivators to prevent their sowing the wrong seed. Altogether the Department distributed 18,255 lbs. of Broach seed in the Southern Maratha Country in the year under report in addition to 9,820 lbs. of Kumpta.

Well-Boring Experiments.

For some years Government have been desirous to carry on some trial borings in the wells of Northern Gujarát upon which all the rabi cultivation of that district is dependent. The Agricultural Department was entrusted with the work and a commencement was made before the close of the year 1907-08.

Operations were commenced at the end of the month of May 1908, and the boring apparatus used was the common Jumper. Three sets of these, each in charge of a Mukádam, were placed under an Overseer, who is a 2nd grade subordinate of the Public Works Department, whose services had been lent to the Agricultural Department for the purpose. A good deal of time was taken up in getting the Mukádams trained and little progress was made before the monsoon of 1908. Meanwhile the Overseer was deputed to the United Provinces to learn the methods of boring adopted there. On his return it was decided to substitute the Cawnpore Boring Apparatus for the jumping tools as these had given very little satisfaction and one complete set of the Cawnpore apparatus was obtained from the Director of Agriculture, United Provinces, while three other sets were prepared locally. Work was resumed in September 1908, but it was some months before the three locally prepared sets were ready for use. At first excellent progress was made with these new tools due perhaps to the effect of the monsoon but later a bad spell was struck and on several occasions a depth of 80 feet was reached without striking water. Hitherto work had been practically confined to Nadiád Táluka but it was decided to try elesewhere when it was seen that the prospects of finding water were not promising. This move was rewarded by a fair amount of success and several wells were subsequently bored with satisfactory results. Altogether 25 wells were bored with the Cawnpore apparatus of which 15 proved successful and 10 proved unsuccessful. A well was called successful when water sufficient for one or more koses was tapped. The average cost per well was Rs. 155 (Rs. 86 for labour, Rs. 69 for piping.) The average depth bored was 63 feet and the average cost per lineal foot for labour was Rs. 1-7-1. With the old boring tools the average cost per lineal foot was Rs. 3-1-6. Only 3 successes were obtained out of 9 borings with the old tools. The labour charges appear high but this is due to the excessive wages which had to be paid for coolie labour. In the Kaira District it was found nesessary to pay 6 annas per day to a coolie. The success of a boring of course depends not only on the quality of the labour and tools used but also on the presence and depth of the subsoil water which of course can only be surmised until a boring is actually made. Under the circumstances 60 per cent. successes as with the Cawnpore tools should justify the work being continued in view of its great importance. With the experience we now have, it may be found possible to pick out the wells likely to prove successful with more satisfactory results. A detailed report of the work and expenditure thereon has been prepared by Mr. Nagindás, the Overseer in charge of the Boring Operations.

T. FORSTER MAIN,
Deputy Director of Agriculture.

APPENDIX B.

Summary of Experimental Work under the Deputy Director of Agriculture in Sind.

The work in Sind during the past season has greatly increased and the Departmenet is now getting much more into touch with cultivators and zemindárs. On the whole there is little necessity for very elaborate experimental work in the present state of agriculture in Sind The prime necessity is to get the ordinary rules of good cultivation adopted. The country already possesses excellent varieties of the chief staple crops and some important introductions have been made and the main object is now to get the average standard of cultivation raised. It has been proved without doubt that very intensive cultivation can be adopted if only some simple rotation be practised. Leguminous crops are conspicuously absent in Sind owing to the scattered methods of cultivation, and a careful study of suitable varieties for introduction into ordinary cultivation has been a main part of the work at Mirpurkhás.

Pulses.

A number of common Presidency pulses have proved successful and even if only grown before one specific crop like wheat would exercise a most beneficial effect. Tur seed has been extensively distributed into Upper Sind, greatly owing to the influence of Mr. Lawrence, the Collector of Sukkur.

Rotations.

Two common Egyptian rotations suitable for cultivation on a perennial canal are being worked out at Mirpurkhás but owing to defective water-supply on the Jámráo have not had time to show definite results.

Berseem (Egyptian Clover).

The berseem has suffered badly for the last two years from the aforementioned cause, but it has been shown at Doulatpur that it will thrive well in Sind where it can get rabi water. To encourage the growing of this crop is of the greatest importance and it is hoped that a considerable amount of seed may be raised in Sind in another year for distribution. At present the cost of seed which has to be brought from Egypt is a disadvantage. Compared with all the other pulses it is far ahead of them in its capacity of nitrate collection as an examination of its root nodules will easily show.

Cotton.

During season 1908 Egyptain cotton was not very successful. 4,000 acres were sown, most of it very late. Difficulty was also experienced in getting rid of cotton sent to the auctions at Mirpurkhás. Eventually it had to be sold privately @ Rs. 9 for Abassi and Rs. 8-6-0 for Mit-Afifi per maund. In 1909 no Egyptian cotton has been sown as no water was available for sowing at the proper time. In the light of experience gained in former years plans for improving the method of cultivation and marketing have been worked out and will be adopted next season. It is proposed to get the area up to 10,000 acres and produce a uniform grade and get it sold direct by the British Cotton Growing Association.

Of the trial sowings of American cotton in various districts they all did reasonably well but will not at the present price of Sindhi cotton be as profitable as the latter. Dhárwár-American cotton on the Nasarat Canal did well and its cultivation is being extended this season.

An interesting trial is being made of Lower Sind cotton in Upper Sind. The small amount of cotton grown there is of a different type to the former. If Lower Sind cotton is successful it should be a most profitable crop in Upper Sind as it is a very hardy and prolific variety.

Miscellaneous.

Some interesting results are obtained with wheat at Mirpurkhás, several good varieties are now ready for distribution to replace the present somewhat mixed crop cultivated. The wheat buyers complain a great deal about this admixture in Sind wheats, red, white, hard, soft all together and sometimes a little barley.

Various trials of new crops were made during the season along with manurial and other experiments. They are all fully mentioned in the various farm reports.

Alkali Experiments.

At Doulatpur Station good progress has been made in sweetening the land though there was the usual cry of want of water. In 1908 this was varied by flooding owing to the

phenomenal rainfall experienced. The cost of working has been low and the work is up to estimate. At present 100 acres of cotton and 100 acres of bájri, etc., have been given out on rent and where the rice and berseem were good the crop is excellent. This land formerly analysed over 3 per cent. alkali salts and is scheduled as "unculturable kalar."

New Central Station.

A Farm at Sukkur on the Indus is being laid out as a centre for agricultural work in Upper Sind. It will be irrigated by pump direct from the Indus.

Demonstration Plots.

Arrangements have been made to obtain the loan of 10 plots of from 4 to 10 acres each in North and South Hyderabad and in Sukkur. On these are being grown cotton, cereals, pulses, etc., in order to bring these more prominently to the notice of cultivators. Several seed stores have also been opened in these districts in connection with the sub-stations.

These sub-stations cover a very large extent of country which it is impossible to get in touch with from the Central Farms. They form the head-quarters of the various Probationers who are acting as Instructors. They are being worked without any expense to Government.

Implements.

The need of a cheap and effective plough has been met by the design of a modification of the native Egyptian plough. A Workshop has been opened to supply these and other implements suited for local conditions. In some cases zemindárs are getting these implements made locally after having seen these being worked.

Reaping machines were taken round the wheat growing area at harvest time and were worked on zemindárs' own lands.

Shows.

During the season Agricultural Exhibitions were held at Shikárpur, Talhár and Hyderabad. They were accompanied by demonstrations of working implements and lectures. The first two were in connection with local fairs. Much interest was taken in these and they will be repeated when possible.

G. S. HENDERSON,

Deputy Director of Agriculture, Sind.

APPENDIX C.

Summary of Experimental Work under the Professor of Agriculture.

Sugarcane.

Investigations with regard to best system of rotation, more economical methods of manuring and irrigation, and the manufacturing of the product into gul or sugar, were in hand during the year. The work was carried on at the Sugarcane Station at Mánjri, the sub-station at Bárámati and in some villages in Sátára.

1. Investigations with regard to rotation :—

It has been proved beyond all doubt that under the conditions of irrigation soil etc. found in the Poona District, that cane cannot be grown to advantage continuously year after year as it is often in other parts of the world. Just how long the land should rest between the consecutive crops of cane, and how the land should be occupied during this period to give the most returns, and also leave it in the best condition for the new cane, is a question requiring considerable study. The practices of cultivators vary considerably in this respect. On account of the limited area at our disposal at Mánjri, only one experiment is in hand. The number of years that should intervene between two crops of cane depends largely upon the nature of the soil. The finer and deeper the soil the longer it will take for it after heavy irrigation necessary for sugarcane to regain its normal condition, but, I believe we may lay it down, that it will be of the greatest advantage to allow at least two entire years to elapse between two crops of sugarcane. Obviously an unirrigated crop should follow cane, in order that it may regain its proper physical condition, which the heavy irrigation may have damaged, and also to enable the deep rooted weeds Hariyáli (Cynodon Dactylon) and Lavála (Carex Indica) so persistent under perennial irrigation to be eradicated; unless the cane is harvested very early this will not be accomplished in a single year in time for a rainy season (kharif) crop. We are therefore restricted to a cold weather or rabi crop, such as wheat or gram. The latter, belonging to a different class of plants from cane, would seem to be the best. In our rotation we have used both wheat and gram, but for lack of room only gram will be used hereafter.

The treatment for the second year is even more varied. If cropped it must be with a crop that can be kept free from weeds and that can be harvested early and the land prepared in time to plant cane in February. Many take a crop of fodder jowári. The greatest objection to this is that the worst insect pest, the sugarcane borer, may thereby gain a foot-hold. Also, the jowári being so closely related to sugarcane botanically, it uses up the same soil constituents. However, the cultivator needs fodder which is a strong argument in its favour. Others fallow the land or grow San (Crotollaria juncea). The results of this year do not show any advantage from the fallowing or green manuring, whereas by growing jowár nearly fifty rupees worth of fodder was secured at a less cost than either bare fallowing or green manuring. The reason for there being no advantage shown from either of these practices lies in the fact that the plots all received a very heavy dressing of manure, which supplied all the plantfood required. The quantity of manure applied will be considerably reduced in the next year of this work, and we shall probably see a greater difference in the results.

2. Manuring experiments :—

These relate (*a*) to trials of mineral nitrogenous manures, (*b*) to investigations of the potash and phosphoric acid requirements of sugarcane, (*c*) to investigations as to how far safflower cake may economically replace farmyard manure; whether it may be used alone advantageously and further to compare it with castor cake and fish manure; (*d*) to trials of smaller applications of manure, at Bárámati, than the cultivators now use to see if the results obtained under conditions at Mánjri would hold in the Nira Valley.

Mineral Nitrogenous Manures.

In all our experimental work we have taken for our standard manure 26 loads (20,830 lbs.) farmyard manure and a top dressing of 26 maunds (2,090 lbs.) safflower cake. This furnishes 350 lbs. of nitrogen. This quantity of nitrogen we have found as the result of previous year's work the most economical quantity of nitrogen per acre.

Sulphate of ammonia was tried in different quantities both alone and with safflower cake, on new cane and ratoon cane at Mánjri. It was also tried at Bárámati. This is without doubt the most promising of the mineral manures for cane. The nitrogen seems to be more efficient per unit than in safflower cake. It was bought at the rate of 9 lbs. per rupee and when supplied as a top dressing it was given at the rate of 710 lbs. per acre costing Rs. 79. Safflower cake to furnish the same amount of nitrogen would cost only about Rs. 59 but the outturn from plots treated with sulphate of ammonia was from 19 to 20 per cent. greater. When used in connection with safflower the yield was largely increased. 355 lbs. were used per acre with 13 maunds (1,040 lbs.) of safflower cake, the two costing Rs. 67 per acre.

Crude nitre is another manure that gives a good yield, but at the present price, it will not pay, as compared with oil cake. In order to give a top dressing as rich in nitrogen as the one mentioned above, requires 1,542 lbs. per acre which would cost Rs. 96.

Calcium nitrate was tried on one plot; it is inferior to either of the above and costs Rs. 139 per acre.

The experiments with regard to *potash and phosphoric acid* for the year under report yield no very definite information.

Experiments with various quantities of safflower cake alone and in combination with farmyard manure, give the following result :—

Safflower cake as the sole manure will yield as good crops and give as great profit in the first year as when used in combination with farmyard manure.

Irrigation Experiments.—Both the interval between two consecutive waterings and the quantity at each application were included in our experiment. The results of the year go to confirm those of previous years, namely, that a total of about 350,000 cubic feet per annum with intervals of 8 days in hot weather and 10 days in cold weather is the most advantageous watering for soils of Mánjri description. This is equal to an average application at each watering of about 2½ inches of rainfall or about 96 inches total water inclusive of rainfall or a water duty of 90 acres.

After a study of the local practices at Bárámati 400,000 cubic feet per acre per annum was taken as the normal quantity. A reduction of this quantity by ½ only slightly reduced the outturn when the interval was kept at 10 days, but when the interval was increased to 12 days there was a loss of over 1,000 lbs. of gul per acre. On the other hand, when the interval was decreased to 8 or even 6 days it was not attended by any appreciable increase in yield.

This again brings out the necessity of not allowing the interval between two consecutive irrigations of sugarcane to exceed 10 days, and the fact that if this is done, the quantity now applied may safely be reduced by one-half or to 202,500 cubic feet per acre, thus increasing the water duty to 140 acres, for the deeper and more retentive soils like our plots at Bárámati.

Experiments in cane crushing.—The sugarcane of the Poona District is crushed by a vertical three-roller bullock mill. This is far ahead of the older wooden or stone mill in efficiency, and, when carefully adjusted, gives a very good extraction. But when the work is done by contract as is the usual custom, in order to save the bullocks the mill is often adjusted and fed so as to pass the largest possible quantity of cane through without being over-careful to secure a high extraction. It is very difficult to say just what the actual per cent. of extractions is in such cases, but, probably from 56 to 66 per cent. of the weight of the cane, according to its quality and ripeness.

A horizontal three-roller crusher by Ruston and Proctor driven by an 18-horse power oil engine was established at Mánjri in 1907 to enable us to crush experimental plots more speedily. It was immediately evident that there was a considerable saving of juice and of labour. The average extraction from this mill in 1908-09 was 67·8 per cent. of juice over the cane. This included cane of all conditions, ratoon, etc. But with average first year's cane the percentage of extraction was 69 per cent. We can safely say that there is an increase of 5 per cent. of juice on cane over the bullock mill, as it is usually run. This means a gain to the cultivator of Rs. 40 per acre on a crop yielding 40 tons of cane or a rupee per ton of cane. The cost per acre of 40 tons will be about Rs. 8 less than with the bullock mill.

A six-roller mill by Manlove Alliot and Company was installed at Bárámati in the beginning of May, which was too late to make a thorough test before the rains broke. A few preliminary tests indicate the ability of this plant to give an extraction of from 5 to 7 per cent. higher than the 3-roller plant, at a cost of only Rs. 3-8-0 per acre more for crushing. The cultivators are convinced of the great gain, and two orders for power crushers have been given, while there are several more enquiries.

Poona Furnace.—The furnace in use in Poona District is a considerable improvement over those in use in other parts in point of saving of fuel. Its advantage lies in having a smaller pan and a separate ash pit and draft flue. There is a considerable saving of fuel effected. In Sátara from Rs. 30 to Rs. 40 per acre are expended for fuel, while by the Poona method the megass and trash alone suffice to boil the juice. Two Poona furnaces are required to deal with the same quantity of juice as the Sátára pan. This requires an extra pan-man (Gulwa) although no extra fireman.

Sugar making.—On account of the numerous enquiries concerning sugar making by Hādi process, a furnace of the pattern used by Mr. Hadi was constructed, and sugar made by this method. The hand centrifugal was used. Numerous visitors came to see the working of the process. The results show that a good quality of sugar is possible. The results can best be understood if we compare the cost of sugar with the gul. In doing this we find that when gul sells at Rs. 16 per palla (252 lbs), sugar must be sold for Rs. 9 per maund of 80 lbs. to be equal in profit to gul making, which is one rupee higher than the current rate for ordinary sugar. Swadeshi sugar brings any price, and it is hard to say what a quantity of it would fetch, but probably from Rs. 10 to 12 at present. The supply is very limited, hence the high rate. The Ganges Sugar Works near Cawnpore get Rs. 10 per maund of 97 lbs. or Rs. 8-4 per standard maund. The cost of production by the Hadi process may be considerably reduced when carried on sufficiently large scale to enable one to use a power centrifugal.

Cotton.—Irrigated Broach cotton gave average yields of about 1,000 lbs. of seed cotton per acre. When valued it was found to be inferior to regular Broach.

Experiments with other varieties of cotton in light land under irrigation proved that ordinary Varadi will pay a moderate profit, even on the shallow soils. Only two waterings from rabi water were required.

At Bárámati Broach cotton as well as the others did very poorly. On account of the salt in the soil cotton cannot be grown to advantage in the Nira Valley.

Wheat.—When Mr. Gammie was collecting wheats for his study he gathered a large number of varieties of wheats and since then representative varieties of each class have been grown on College Farm on a small scale. Seven of these varieties were taken to Mánjri for further trial on a field scale. Among these two Australian varieties have yielded over 3,000 lbs. per acre on deep, well manured soil under canal irrigation; they are soft white in character. A hybrid from Nagpur yielded 3,277 lbs. per acre; it is soft white of the Poptia type. Of the hard varieties Malia of Belgaum, Sia Das, Paman of Sirsa gave over 2,000 lbs. Seeds of these varieties are available at Mánjri Farm.

At Gokák the wheat is dibbled on the sides of the ridges. This method was tried at Mánjri in comparison with local methods. Although there was a slight gain in outturn there is an extra cost of cultivation.

Kála Kusal (hard white) sown by students yielded 2,700 lbs. per acre.

Groundnuts.—Exotic groundnuts were introduced into Southern Sátára and the neighbouring States about 8 years ago, and they have gained such a foothold in Karád, Válva and Pátan tálukas that scarcely a single field can be found with the local variety. The profits from the cultivation of this crop are about Rs. 25 per acre. Distribution of foreign seed has been continued year by year since 1905. During the year under report 13,654 lbs. of seed of large Japanese, small Japanese, Spanish peanut and Pondicherry was distributed in Nagar and Ráhuri tálukas of Ahmednagar, Sholápur and Bársi tálukas of Sholápur, Násik, Chandvad, Sinnar and Yeola tálukas of Násik; Virginia and large Japanese are preferred in Válva and Bársi tálukas. They require about 5 months to ripen. Pondicherry ripens in 4½ months and is popular in Karád and Pátan Tálukas. Small Japanese and Spanish peanut require 4 months. These are all so much earlier than the indigenous variety that they can be grown wherever the rainfall is over 35 inches without irrigation, or in cases where it is somewhat lower than this, only a few waterings are required. Moreover, on account of their earliness, they are much less affected with the Ticca disease than the local variety.

Work on the farms with this crop was confined to comparing the yields of the different varieties and studying the best distances at which the rows should be sown. At Mánjri on very good medium soil the immense yield of 5,400 lbs was obtained with the big Japanese, whereas on the lighter soil of the College Farm the biggest yield was obtained with the small Japanese. There seems to be very little difference between large Japanese and Virginia and between small Japanese and Spanish peanut. But the larger varieties yield as a rule a little more. All yield rather better than the indigenous. Experiments at College farm bring out that thicker sowing is necessary in the case of small varieties. The following are the best distances:—

For small Japanese and Spanish peanuts 6″ by 4″; seed rate 200 lbs.

For Pondicherry 9″ by 6″; seed rate 85 lbs.

For large varieties 9″ by 12″; seed rate 80 to 90 lbs.

Rice.—The ráb experiments at Lonávla were continued.

Ráb is the name given to materials, such as branches, cowdung or other substances which are burned as a preparatory treatment upon the seed bed wherein rice seedlings are grown for transplantation in the fields. This custom prevails in the western parts of Bombay Presidency, where the rainfall is from 50 inches to 200 inches. This system of rice cultivation is objected to because of its injurious effect upon the forest where branches are used and the waste of nitrogen in the case of cowdung. Investigations of the practice have been going on since 1904 with the objects in view, first to find the reason for the beneficial action of the ráb and the second to find a substitute. The results of the year are in line with those of previous years, in that they show that the greatest factor in the ráb is not the ashes but the heat, but how this acts is not settled. Several substitutes have been found to be as efficient as ráb. Among them are fish manure, nitre, oil cakes, sheep folding and cowdung ploughed in. About 120 lbs. of fish, 20 lbs. of nitre, 120 lbs. of karanj or niger oil cake, 80 lbs. of safflower cake, one cart of poudrette, a small cart of farmyard manure or 100 sheep folded for four days will give as good a supply of seedlings as ordinary ráb. The cost of these various substitutes will vary with each location but in general if ráb material has to be carried very far, they will not be very much more expensive than ráb.

The experiments in field manuring gave indecisive results probably due to water flowing from one plot to another at the time of heavy rain.

218 varieties from Bombay and Bengal were again grown for verification of the classification. Some are worth trying on a large scale. This will be taken in hand later.

Cultural experiments with regard to conservation of soil moisture, irrigation water, and the reclamation of land injured by over-irrigation.—This has formed a very important feature

of my work during the past year. It may be considered under "Dry farming" at Ráhuri and at the Agricultural College Farm, inundation experiments at Bárámati and Mánjri and salt land reclamation experiments.

The Ahmednagar work is divided into two distinct lines of work. The first was the damming of small streams and directing their water by water-courses to land that has previously been levelled or terraced and protected by small embankments. The results are most encouraging as over 900 lbs. of jowár and nearly 500 lbs. of wheat were obtained from fields treated this way when lands not so treated produced yields of only 300 lbs. of jowár and 250 lbs. of wheat. The annual cost of this treatment comes to about Rs. 1-8-0 per acre including labour of diverting the water, interest and repairs on the original work. The dam cost Rs. 197 and the terracing and embankments Rs. 7 per acre.

The other work at Ráhuri had reference to deep ploughing, intertillage, width of seed drills and differing seed rates. Deeper ploughing before the rains for a rabi crop gave an increase of about 60 per cent. The results from better intertillage were very confusing. The beneficial use of a wider drill is strongly indicated as fields in which seed drill having the coulter 18″ apart were used gave 30 per cent. greater than those sown with the usual implement whose lines are only nine inches apart from each other. One-half and one-fourth the usual seed-rate increased the outturn of grain but diminished that of fodder. At the College Farm, Poona, during the kharif season, the wider drill did not show any advantage. Here there was a considerable improvement noticed from better tillage, when the plots of nearly uniform conditions are compared.

Experiments to raise rabi crops by levelling and bunding the fields and impounding heavy application of kharif irrigation water in order to grow rabi crops were undertaken at Mánjri and Bárámati. At Mánjri they were sown to Kála Kusal wheat, Australian, and Khapli. The yields are over 800 lbs. for the Australian, nearly 700 lbs. for the Kála Kusal while Khapli produced only 600 lbs. per acre. This outturn is much below irrigated wheat, but the cost of cultivation is about half as great. Moreover Khapli and Kála Kusal were not adapted to this mode of cultivation. Sudhe (Shet Parner) will be tried next year. Even poorer results were obtained at Bárámati. I think if one good irrigation be given in November a very much bigger crop can be obtained.

The work on the reclamation of salt land in co-operation with Dr. Mann gives hopeful results. The line of work is drainage by open ditches. Upon land not too far gone we were able to raise a crop of Mánjarwel rice from seedlings raised on sweet land. The outturn of course was low.

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APPENDIX C-1.

Experimental work in conservation of moisture in regions of Light Rainfall.

Introduction.

The subject of "Dry farming" or better the study of utilization to the best advantage of the water which falls in an arid tract is one that is very important in India.

Experiments in this line were commenced in 1908. A plot of land was hired from the estate of Dr. W. O. Ballantine of Ráhuri on the share system in the village of Khadamba, three miles from Ráhuri, in the Ahmadnagar District.

A rain gauge was not available hence the meteorology of Ráhuri is given for these experiments:—

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September	October.	November	December.	Average rainfall. Total.	
1908 ...	...	...	...	...	...	1·84	0·63	2·25	8·74	0·22	...	...	13·73	...
Average ...	0·15	0·22	0·14	0·35	0·95	5·31	3·33	1·70	5·59	1·83	0·66	0·22	20·45	20·45

Lines of work.

The work was conducted along the following lines:—

(1) The inundating of fields by means of saving the water that usually drains off through the nálas.

(2) The attempts to give the soil greater absorptive power by very deep ploughing and through harrowing.

(3) The attempt to lessen the loss of water from evaporation by means of an earth mulch formed by frequent shallow tillage.

(4) An attempt at thinner seeding and wider spacing to allow the individual plants to get more water per plant and thus admit of more nearly perfect development.

It was proposed also to try "subsoil packing" but the subsoil packer did not arrive in time.

Selection of Crops and Land.

The crops selected were jowár and wheat. The land chosen for the first set of experiments consisted of 7 acres good level black soil. That for the other experiments was 12 acres of ordinary Deccan land of medium quality and varying more or less in character.

Experiment No. 1.

Saving of drainage water by embankments.—A small nála was dammed by a masonry 26 feet long and 7 feet high costing Rs. 197-10-3.

Details of method.

The sides of the nála were raised for some distance up-stream. Provision was made for freshets by the construction of a sluice way in which a simple gate of pieces of board was formeh which can be removed whenever the water gets too high. The water is taken to the fields througd side gateways of the same description. These can be closed whenever there is danger of too much water. From the gate the water is distributed by water courses the same as in canal irrigation. The fields need to be levelled and terraced and bunded by simple earth embankments. These cost about Rs. 7 per acre. It is my purpose to utilize only the smaller falls of rain when the stream of the nála is small and manageable but to allow the heavy rains which fill the nála to an unmanageable extent, to flow away through the sluice way and over the dam. The water is impounded as often as possible till the time for sowing comes. A considerable quantity of silt is deposited. The land should be thoroughly ploughed as early as possible. The work of the dam was not completed in time to utilize all the earliest rains but several of the later ones were saved. The area was divided into 6 plots by bunds and 3 plots sown to jowár and 3 sown to wheat.

Results.

The general appearance of the crops in the land that received inundation water was remarkably good throughout the season, visiting cultivators remarking that they looked like irrigated crops. The average yield of jowári for these plots aggregating 3 acres 34 gunthas was 921 lbs. of grain and 1,514 lbs. of fodder per acre; whereas the average of similar adjoining land belonging to Dr. Ballantine and cultivated in the usual way the same year was only 312 lbs. per acre. The average yield of dry (Sudhe) wheat from these plots aggregating in area 3 acres was 493 lbs. grain and 452 lbs. bhusa per acre, neighbouring land planted the same day and as carefully harvested and weighed gave only 240 lbs. of grain and 200 lbs. bhusa per acre. A small plot (13 gunthas) of bakshi gave a yield of 526 lbs. of wheat per acre.

Cost.

The cost of actual cultivation was no more than ordinary. The dam cost Rs. 197-10-3 and is permanent or at least good for several years. The dam commands about 40 acres which could be treated the same way if they were levelled and bunded. So that the proportional annual cost is quite reasonable. The bunding, levelling and small water courses cost about Rs. 7 per acre. If the interest and repairs be taken at 10 per cent. on 40 acres the annual cost comes to Rs.1-3-0 per acre with a gain of 609 lbs. per acre in jowár and 253 lbs. per acre in the case of wheat. Even better results than this may be expected next year. The method of saving water is applicable to comparatively only a very few numbers but wherever it is possible it should be used.

Scheme of treatment and plotting of Experiments 2, 3 and 4.

As has been said the second field was somewhat uneven in character. This was to a large extent overcome by plotting transversely to the irregularities and by triplicating the plots. The plots were 16 gunthas in area. The field was protected by embankments from washing which were strengthened at the beginning of the year but a freshet of cloud burst of 2 inches or more in a few hours breached them and washed through the plots.

Experiments 2, 3 and 4 were all carried on in this field. The sketch below shows the scheme of treatment :—

Frequently intertilled ...	1 Row 9″ apart 2 „ 18″ 3 „ 18″ 4 „ 18″ 5 „ Wheat	Deep ploughing	Seed rate ordinary. „ „ „ One half ordinary. „ One-fourth. „ Drill.
Once intertilled ...	1 Rows 9″ apart 2 „ 18″ 3 „ 18″ 4 „ 18″ 5 „ Wheat		Seed rate ordinary. „ „ „ One half ordinary. „ One-fourth. „ Drill.
Frequently intertilled ...	1 Row 9″ apart 2 „ 18″ 3 „ 18″ 4 „ 18″ 5 „ Wheat		Seed rate ordinary. „ „ „ One half ordinary. „ One-fourth. „ Drill.
Once intertilled ...	1 Row 9″ apart 2 „ 18″ 3 „ 18″ 4 „ 18″ 5 „ Wheat		Seed rate ordinary. „ „ „ One half ordinary. „ One-fourth. „ Drill.
Frequently intertilled ...	1 Row 9″ apart 2 „ 18″ 3 „ 18″ 4 „ 18″ 5 „ Wheat		Seed rate ordinary. „ „ „ One half ordinary. „ One-fourth. „ Drill.
Once intertilled ...	1 Row 9″ apart 2 „ 18″ 3 „ 18″ 4 „ 18″ 5 „ Wheat		Seed rate Ordinary. „ „ „ One half ordinary. „ One-fourth. „ Drill.

Ordinary Ploughing.

Results of Experiment No. 2.

It will be seen that the field was divided into 2 plots of 6 acres each. One half was ploughed with turnwrest Arlington plough followed by a deep-going native plough in the furrow, just behind ; the other half was ploughed in the ordinary way.

The results are given below :—

	Average yield per acre.		
	Grain.		Fodder.
Deep ploughed portion	439		2,134
Ordinary ploughed portion	274		2,178
Increase due to better ploughing ...	165	loss	—44

The increase was in grain only due to the fact that there was sufficient moisture for maturing the gain. The gain of 165 lbs. per acre is made at an additional cost of Rs. 3-2-10 per acre. Ordinary ploughing cost Rs. 4-13-6 and the deep ploughing Rs. 8-0-4.

The breaching of the bunds of the field affected the results to some extent but not sufficiently to vitiate them but these results need confirming by additional experiments. Still, they point to the great value of deep and thorough ploughing in the deeper soils of the dry tracts.

Experintment No. 3 to save moisture by more intertillage.

The results with this line of work were rather disappointing on the whole, as the average outturn of grain for all often intertilled plots is only 337 lbs. per acre while for the ordinary tilled it is 375 lbs. per acre. The loss in grain is probably due to the breaking of the stalks during the frequent operations. It may be that the work was begun too long after planting. Only the usual country bullock hoe was used. Next year tillage will take place weekly from sowing till the crops are too large for passing the bullock between them and several new implements will be tried.

Experiment No. 4—Spacing and seed rate.

In arid countries thin seeding permits individual plants to get more water and thus they develope more perfectly. Seed drills of two widths 9″ and 18″ were tried and the detailed results are tabulated below.

The block figures show averages :—

Seed rate.	Ploughing.	Intertillage.	9 inches seed drill.		18 inches seed drill.	
			Grain.	Kirbee.	Grain.	Kirbee.
Ordinary ...	Ordinary ...	Frequent ..	150	2,450	201	2,400
Do.	Do. ...	Do. ...	30	2,570	48	2,645
Do.	Do. ...	Do. ...	240	2,330	295	2,690
			140	2,450	181	2,578
Do.	Deep ...	Frequent ...	255	2,430	380	3,195
Do.	Do. ...	Do. ...	275	1,370	398	2,340
Do.	Do. ...	Do. ...	475	2,210	640	2,435
			335	2,003	473	2,657
Do.	Ordinary ...	Usual ...	378	2,515	360	3,070
Do.	Do. ...	Do. ...	16	2,415	35	2,225
Do.	Do. ...	Do. ...	245	2,505	385	1,784
			214	2,478	260	2,359
Do.	Deep ...	Usual ...	307	2,505	547	3,540
Do.	Do. ...	Do. ...	267	2,730	213	2,660
Do.	Do. ...	Do. ...	405	2,365	502	2,745
			326	2,533	420	2,985
			253¾	2,366	333½	2,644¾
One-half ...	Ordinary ...	Frequent ...	...	...	396	2,265
Do.	Do. ...	Do. ...	...	...	97	2,250
Do.	Do. ...	Do. ...	...	...	460	2,415
					318	2,310
Do.	Deep ...	Frequent ...	...	...	260	2,115
Do.	Do. ...	Do. ...	...	...	408	1,635
Do.	Do. ...	Do. ...	...	...	575	1,825
					414	1,862

Seed rate.	Ploughing.	Intertillage.	9 inches seed drill.		18 inches seed drill	
			Grain.	Kirbee.	Grain.	Kirbee.
One-half ...	Deep ...	Usual ...	...	...	625	3,080
Do.	Do. ...	Do. ...	...	...	415	1,940
Do.	Do. ...	Do. ...	...	...	667	1,820
					569	2,281
Do.	Ordinary ...	Usual ...	...	...	320	2,910
Do.	Do. ...	Do. ...	...	...	200	2,295
Do.	Do. ...	Do. ...	...	...	545	2,005
					355	2,405
One-fourth .	Ordinary ...	Frequent ...	...	...	468	1,295
Do.	Do. ...	Do. ...	...	...	260	1,610
Do.	Do. ...	Do. ...	...	...	435	1,270
					388	1,321
Do.	Ordinary ...	Usual ...	...	...	240	2,145
Do.	Do. ...	Do. ...	...	...	480	1,255
Do.	Do. ...	Do. ...	...	...	290	965
					337	1,455
Do.	Dee ...	Frequent ...	...	...	255	1,930
Do.	Do. ...	Do. ...	...	...	540	1,395
Do.	Do. ...	Do. ...	...	...	558	1,053
					451	1,460
Do.	Deep ...	Usual ...	...	...	530	1,565
Do.	Do. ...	Do. ...	...	...	515	1,190
Do.	Do. ...	Do. ...	...	...	528	1,135
					524	1,297

The better results with the wider drill with the same seed rate are very marked. There is an increase of 80 lbs. of grain and nearly 300 lbs. of fodder due to the wider rows at no extra cost to the cultivator. This is also borne out by my previous experience when in Nagar and by the experience of others who have cultivated jowár in this manner.

Results from different seed rates.

It will be seen that with 18″ drill the half seed rate gives 81 lbs. more grain than the full seed rate but about 400 lbs. per acre less kirbee. When the field is near a large fodder market where fodder fetches a good price there is no advantage in the smaller seed rate but for places a long distance away the increase in grain will be more valuable than in fodder. But if the 18″ drill with half seed rate be compared with ordinary drill and full seed rate it will be found that there is an increase of 161 lbs. more grain with only 152 lbs. less fodder. This gain is obtained without any outlay by the farmer.

All the yields reported are extremely low as the rainfall was 7″ below normal and practically no rain after October 1st.

These experiments however are very promising in that they show the possibilities of these methods of cultivation. The simple expedients of using wider drill and less seed make it possible to get 400 lbs grain per acre. While if to these be added more thorough ploughing nearly 500 lbs. of grain is possible even under the adverse conditions of rainfall of the year. Plots treated in usual way gave less than 200 lbs. of grain per acre.

While I would like for some intelligent men to try the methods experimentally I would not advocate wholesale adoption based on only one year's results, however good they may be.

J. B. KNIGHT,
Professor of Agriculture.

APPENDIX D.

Summary of the Work under the Economic Botanist.

Ganesh Khind Botanical Garden.

Season.—Rainfall less than average by 10 inches; crops in the gardens not adversely affected.

Rubber.—Ceara does not stand the long dry season and gives very little rubber. The other rubbers are merely specimen plants.

Jute.—Results of experiments up till now show that—

In Bombay Presidency jute requires rich soil and plenty of water.

Jute must be planted not later than beginning of April.

Given these conditions and Poona climate jute can be obtained equal in quality to fair to good Bengal though of less outturn.

Jute can be grown in rotation with gram. The cultivation is expensive. The fibre produced in Ganesh Khind has been readily bought by Mangs.

Cotton.—The Bourbon plants produced their third crop, of improved colour and staple but less outturn than in preceding years, valued at Rs. 300 per candy.

There has been no cultivation save weeding.

Spence cotton was valued at Rs. 325, *i. e.*, Rs. 25 higher than fine Navsári.

Dhárwár American shows no improvement.

Crossing Dhárwár American and Ghogari seems to have improved the strength at the expense of the length; valued at Rs. 250 per candy. Buri has improved in feel and staple; valued at Rs. 245 per candy.

Calcium Cyanamide.—Adversely affected several kinds of pot plants with the exception of roses.

Wheat.—It has been found that—

1. The degree of rust attack is controlled by very local conditions. Hence one cannot from one series of plots deduce the resisting power of a given variety.
2. Late planting conduces to bad rust attack.
3. Moisture, general or local, favours rust.
4. Most of the Khapli (Triticum spelta) crosses were very susceptible to rust. The two resistant ones had Khapli as male parent. None of the susceptible crosses had marked Khapli characters.

Tapioca.—Extensive trials of this show that—

1. Tapioca will grow in most of the soils of this Presidency provided they are not stiff and heavy.
2. Tapioca can be grown without irrigation if planted at beginning of monsoon. The crop responds readily to manure.
3. The yield per plant varies from 3 oz. to 11 lbs. according to locality, treatment and age of plant.
4. Water-logging is fatal. Otherwise the plant will stand rainfall up to 60 inches at least.
5. No fungus disease has appeared.
6. If the roots are washed, the bark removed, the tubers sliced and boiled for one hour and the water drained off, it would appear that the roots are then safe for human food.

Pomegranates.—Suffered from scale insects called Aleurodes. Resin wash was used as remedy and proved effective. The Sursa disease is being investigated.

Vegetables.—In the conditions of the Ganesh Khind vegetable gardens (alluvial soil near a river) cauliflower did badly, but all other vegetables, especially Brussels sprouts succeeded admirably.

Sub-crops.—Brussels sprouts did not grow well under irrigated tapioca. Groundnut grew well between vines and kept down weeds. Onions under tapioca were unsatisfactory. Groundnut grew well under apples but badly under tapioca.

General.—The garden is freely used for educational purposes for Agricultural College students and others. A large number of applications for seeds and for information have been dealt with.

Bassein Botanical Garden.

Season.—Rainfall was far below average but well distributed. Agricultural and Horticultural operations were not adversely affected.

Development.—One new road is being made; several of the old ones have been planted with avenue trees. The fruit trees used for stocks have been kept up to number by replacement of blanks.

Irrigation.—4,725 feet of masonry channels constructed during the year, and five more wells brought into use.

Lemon grass.—Grew well and yielded 0·35 per cent crude oil. The pulp was reported to be good for certain qualities of printed paper and worth about Rs. 35 a ton rail free. Lemon-grass oil fetches 8 to 10 rupees per lb. Market limited. If markets can be found the grass will pay well.

Cucumbers.—It was found that the tendency of the fruit to drop off or to fail to swell could be counteracted by topping the shoots. This topping has to be done more closely the further advanced the flower is.

Plantains.—Plants manured with castor cake ripened earlier and gave heavier yield than unmanured plants.

The local custom is to plant plantains shallow but it has been shown that plantains may be set three feet deep without detriment to the fruit and with advantage of great stability.

Plantains may persist for 15 months.

Rubbers.—Ceara grew well in girth but the tops got broken of. Tapping was a failure on account of small amount of rubber got. The other rubbers with the exception of Urceola have made good growth though slow.

Cotton.—In Bourbon cotton growth periods observed were April to August and October to March; harvesting season mid-November to April. It seems a sound principle in pruning this cotton to get the new growth from buds close to the old stem. The cotton is valued at Rs. 240 to Rs. 270 per candy.

Groundnut.—Will not grow under well-advanced plantains, though it will produce a crop under newly planted plantains. Two crops in a year can be got, the rabi crop being not much below the average of the kharif crop. Groundnut suits varkas land.

Cabbages.—Well hardened cuttings are as badly attacked by caterpillars as plants grown direct from seed. The degree of cold got at Bassein is not sufficient for early cabbage culture.

Tapioca.—Plants of 11 months' growth gave yields of from 8 oz. to 17 lbs. tubers. Three of the most yielding plants have been further propagated.

Yam.—Supported plants gave a very much larger yield of tubers than unsupported plants. The support seems a necessity for production of a crop.

Jute.—(See Ganeshkhind report.)

Lucerne.—It has been proved that lucerne can grow quite well all through the monsoon if proper precautions as to levelling and draining are taken.

Asclepias Semilunata.—The fibre is valued at Rs. 60 to 70 a candy with the remark that Rs. 10 more can be obtained for longer fibre. The flowering of this plant seems to be influenced by climate and not by age. Planting on ridges is not desirable on account of washing.

WILLIAM BURNS,
Economic Botanist.

APPENDIX E.

Report of the Poona Agricultural College to June 30th, 1909.

The present is the first annual report of the Poona Agricultural College which has been submitted, as the College was only constituted as a separate institution on January 1st, 1908, when the separation from the College of Science was completed. This fact will perhaps justify a short sketch of the origin and progress of higher agricultural education in the Bombay Presidency until the College was established.

2. The initiation of higher agricultural education in the Bombay Presidency dates from the year 1878. At that time, partly, as a result of one of the most severe famines of the nineteenth century, general attention was turned to the possibility of increasing the resisting power of the country to famine by an improvement of the agricultural methods in practice. As a result, classes were founded at what is now the College of Science, Poona. At first the course was elementary. The object was more especially to produce men who should occupy the position of "*Bhág Kárkun*", known in other parts of India as Revenue Inspector or Kanungo. Students who had successfully passed through the classes were granted the same privileges in Government services as those who had passed the first B.A. of the Bombay University. When first instituted, the classes in agriculture formed a two years' course, and they opened with thirty students. Scholarships on a fairly liberal scale were offered. Unfortunately, however, there were few suitable openings for passed students, and the number attending the classes soon fell off. The course was originally a purely theoretical one, but a step in advance was made in 1880, in introducing a practical element into the course. A farm, ultimately made up to seventy-two acres, was acquired near the College of Science, and used regularly for the instruction of the students.

3. Some time after this came the report of the Famine Commission of 1881, which recommended the creation of Agricultural Departments throughout India, with special officials in every district whose business it would be to watch over agricultural interests, to collect information about agriculture, and to make recommendations or to carry into effect suitable measures for the improvement of the agricultural population. To adequately carry out the suggestions of the Commission, it was recognised that men with a higher agricultural training than had hitherto been obtainable were necessary. It was a good many years before any scheme for giving this training could be brought into practice. Ultimately, however, in 1890, the University of Bombay, after long consideration, decided to grant a 'Diploma' in Agriculture. To obtain this involved a three years' course at the College of Science, Poona, or at the Baroda College, and thus for the first time, Agriculture received University recognition.

4. The result of this change was that, from that time onward for several years, a considerable number of men were trained in the Agricultural Classes at the College of Science. The numbers in the classes, however, rapidly fell off, as (owing to the rules for entrance to Government Service) the men who had obtained the Diploma in Agriculture were given no advantage, except a preferential claim to minor appointments, over those who had merely matriculated at the University. As most of the students entered the course with the idea of turning their Agricultural training to advantage in the public service, it was natural that, as they found the Diploma gave no preferential rights to higher posts in the service, further students ceased to come. The number admitted to the Agricultural Classes, hence, fell to four in 1893, and to three in 1894, while there were none at all in 1895. Not a single student obtained the Diploma in Agriculture from the College of Science from 1897 to 1901 inclusive.

5. In 1897, the first step was taken to remove the causes of the unpopularity of the Agricultural Classes. The standard of admission to the course was raised from the Matriculation to the "Previous Examination," and in consideration of this fact, the Government agreed to give the same privileges to men who had obtained the Agricultural Diploma as to graduates of the University. A still further change took place in 1899. The Diploma course had long been evidently unsatisfactory, and there was a general demand for an Agricultural Degree, to be given by the Bombay University. At last, in September 1899, the University consented and established a regular course leading to the degree of Licentiate in Agriculture. The "Previous Examination" was made the entrance to the course and a thorough training in Agriculture, Chemistry, and Natural Science was demanded. Special stress was laid on the importance of training in practical Agriculture. The course then laid down was that under which the Agricultural classes were carried on until the institution of the Agricultural College in January 1908.

6. In the meantime, higher Agricultural training became popular. The numbers of students receiving the degree increased every year, as follows:—1901 none: 1902—1: 1903—2: 1904—3: 1905—6: 1906—7: 1907—11: 1908—21. This increase of the popularity of the course is partly due to the general increase of interest in Agriculture which has arisen since the terrible series of famines from 1896 to 1901, and partly to the development of the Agricultural Department of the Government of Bombay, and the need of trained men to fill the various positions in connection with it. It is also due partly to the fact that holders of Agricultural Degrees have been given not only the same privileges as other graduates possess in the matter of admission to the Revenue Department of Government, but also, if otherwise qualified, a preferential claim to posts in the Agricultural Department, and to those of District Inspector of Land Records and Agriculture.

7. The increase in the size of the Agricultural classes caused such a congestion at the College of Science that during the year 1905 it was decided to establish a separate Agricultural College. A fine site for a College and farm of nearly 150 acres was secured near Poona,

and a plan for a first class College and Research Institute was drawn up. Construction was commenced in 1907. The scheme includes two buildings—a smaller block, intended for Chemistry and Physics, and a larger block, containing large College hall, museum, herbarium, and adequate facilities for teaching and research in Agriculture, Botany, Entomology and allied subjects. While awaiting the completion of these buildings, the College was temporarily located in a series of houses, which were adapted for College purposes. Until January 1908, it was still attached to the College of Science, but carried on under the supervision of a committee of the Professors responsible for the Agricultural course.

8. Coincidently with the complete separation of the Agricultural College from the College of Science, the Bombay University made a further change in the course for the degree. The scope was extended and made even more practical than before, the standard was raised, and from 1909 the Graduates were to have the title of Bachelor of Agriculture. The dates of the sessions were also altered, and it now runs from June to January, so as to cover the most important agricultural months of the year in the Bombay Presidency.

9. When the College was separately constituted, therefore, the position was as follows:—It was located, temporarily, in a series of bungalows at Kirkee. A new course had just been instituted, embracing several new subjects, and requiring a special term to be held from January to March 1908 to enable the old students to grapple with the new course. And finally, nearly all the staff, with the exception of Professors Knight (Agriculture) and Gammie (Botany), and Messrs. Sanga and Sethna, who were responsible for Veterinary Science, were almost new to the College. The present report is intended to indicate the progress made since that time.

College Buildings.

10. The College had to remain in its temporary quarters during the whole of 1908 and the early months of 1909. The progress in the new buildings was, however, steady, if slow, and it has been possible to enter in the occupation of the smaller block in May 1909,—though it is not entirely completed. This change has already resulted in a manifest improvement in the College work. Even as it stands, conditions are somewhat cramped, but it is now possible to carry on the training under conditions which allow of good work being done. The Chemistry and Physics block which is now being occupied for all College purposes, proves, in use, to be admirably designed and is extremely suitable for its purpose.

11. When the University College Course was constituted, the course laid down by the University for the degree of Bachelor of Agriculture was a new one, and had never been tried. It included a number of extra subjects, involved a higher standard in several others, and required far more practical field work than previously. The differences, as to subjects, may be shown in parallel columns, as below:—

Old Course.	New Course.
First year.	*First year.*
Agriculture.	Agriculture.
Physics.	Geology and Climatology.
General Chemistry.	Physics.
Botany.	General Chemistry.
Trigonometry.	Botany.
	Zoology.
	Veterinary Science.
	Mathematics.
Second year.	*Second year.*
Agriculture.	Agriculture.
Organic Chemistry.	Chemistry.
Botany.	Botany.
Veterinary Science.	Entomology.
Mensuration.	Veterinary Science.
	Agricultural Engineering (including Surveying and Levelling).
Third year.	*Third year.*
Agriculture.	Agriculture.
Chemistry of Agriculture.	Chemistry of Agriculture.
Botany.	Botany.
Geology.	Agricultural Entomology.
Veterinary Science.	Veterinary Science.
Surveying and Levelling.	

12. It may at once be said that the new course has been found unsatisfactory. It is not that there are too many subjects or that these are studied too deeply, but that the arrangement of the course is such as to make it almost hopelessly difficult for the first year students, while those of the final year have, comparatively speaking, an easy time. The new-comers, most of them substantially new to Science, are launched at once into seven new subjects, each with an unfamiliar terminology, and the result is that some become hopeless and leave the course, others persevere and find themselves unable to rise to the standard of examination in every subject.

13. As a result of this evident unsatisfactory character, the Syndicate of the Bombay University has appointed a special Committee to consider its modification. This Committee is expected to report immediately, and it is to be hoped that early action will be taken to make the course a better balanced and more satisfactory one.

College Staff.

14. The impracticable character of the course has not been the only difficulty with which the College has had to struggle during the first year of its existence. On the one hand the staff was almost entirely new: on the other Professors Knight and myself were both attacked with enteric fever in July 1908, and were unable to carry on our duties, the former until the end of September, and myself until the beginning of November. During this time the breach was filled by Professor Gammie acting as Principal, by Mr. W. Roberts, B.Sc., the supernumerary Agriculturist attached to the Agricultural Department, acting as Professor of Agriculture and by Mr. H. E. Annett (belonging to the staff of the Imperial Research Institute, Pusa) filling my place as Professor of Chemistry. Without the assistance of these gentlemen the College would have been necessarily closed, and they are entitled to the greatest credit for the manner in which they filled an unexpected gap.

15. The staff of the College at the beginning of the period under report was as follows with the dates of appointment:—

Principal and Professor of Chemistry	...	Harold H. Mann, D.Sc. (1907).
Professor of Agriculture	...	Jewell B. Knight, M.Sc. (1904).
Professor of Botany	...	G. A. Grammie, F. L. S. (1899).
Assistant Professor of Agriculture	...	G. K. Kelkar (1907).
Do. of Botany	...	H. M. Chibber, M.A. (1906).
Do. of Physics	...	H. K. Mehta, B.A., B.Sc. (1907).
Lecturer in Entomology	...	R. M. Dixon, B.A. (1907).
Do. in Veterinary Science	...	D. D. Sánga, G.B.V.C. (1887).
Do. in Chemistry	...	D. L. Sahasrabuddhe, L.Ag. (1907).
Demonstrator in Agriculture	...	P. C. Pátil, L.Ag. (1906).
Do. in Veterinary Science	...	J. M. Sethna, G.B.V.C. (1904).

16. During the term under report the following changes have taken place:—

(1) Mr. Gammie has retired from the College and from the Bombay Agricultural Department to take the position of Imperial Cotton Specialist under the Government of India. Mr. Gammie has been connected with the agricultural course through a very critical period of its existence, has once acted as Secretary of the Agricultural College Committee and again as Principal, during a portion of the present year.

(2) The appointment of Lecturer in Entomology has been raised to that of an Assistant Professor, and Mr. Dixon, who succeeds to this position, has been also made responsible for Zoology.

(3) Mr. P. C Pátil, who remained as Demonstrator in Agriculture for two years, and to whom great credit is due for the organisation of the practical agricultural classes, was made Inspector of Farms in July 1908. He was replaced by Mr. G. A. Hiremath, L.Ag., who, however, only remained for two months, being then given a position as probationary Deputy Collector in the Provincial Civil Service. His place was then taken by Mr. V. G. Gokhale, L.Ag., who occupies it at present.

(4) Two new positions have been made during the year. The first of these is that of Demonstrator in Chemistry which was taken by Mr. N. V Joshi, B.A., L.Ag., appointed in February 1908: the other is that of Assistant Demonstrator in Agriculture, to which Mr. C. V. Sane, B.Ag., was appointed in June 1909.

Students.

17. The number of agricultural students shows a small but distinct increase during the present period over the figure at which it stood during the previous year. The actual figures are as follows:—

	1906.	1907.	1908.	1909 June 30th.
First year students ...	36	26	31	40
Second year students ...	40	38	39	26
Third year students ...	13	31	34	39
Special students ...	...	...	...	1
Total ...	89	95	104	106

The students during the last and the present years have come from the following parts of India:—

		1908.	1909.
Bombay Presidency...	Deccan	31	32
	Southern Marátha Country.	27	33
	Gujarát	22	17
	Sind	10	9
Eastern Bengal and Assam		7	10
Central Provinces		1	...
Bengal		2	2
Central India		2	1
Nizam's Dominions		2	2

Arranged accordingly to the castes or classes from which they come, the students stand as follows:—

	1908.	1909.
Bráhmins	67	65
Maráthas	3	4
Lingáyats	4	6
Pátidárs (Gujarát)	5	4
Mohammedans	7	7
Parsees	1	1
Others	17	19

18. All these students, except five in the year 1907-08 and eight during the current session, are studying for the University examinations, and all these have passed, for entrance, the Previous examination or its equivalent. The exceptions arose from the fact, that it has been decided by Government to allow scholars to be received from Sind who have only passed the Matriculation examination, provided that they were to receive the same course and pass by the same standard as the University demanded. Under this ruling two scholars (only one of whom remained throughout the year) were sent from Sind in 1908, and one more in 1909. Some applications were at the same time being received from outside the Bombay Presidency both from the Government and from private persons for admission to the College. Most of these had passed the F.A. examination of Calcutta University, but owing to the peculiar regulations at Bombay, this cannot now be counted as equivalent to the Previous Examination, unless it include a Classical Language and History. As there is no Agricultural College in Bengal at present, it has been decided to admit a limited number of such students, under precisely the same conditions as the scholars from Sind. The number now on the College list so admitted is as follows:—

	Admitted in 1908.	Admitted in 1909.
Bengal	1	...
Eastern Bengal and Assam	2	2
Nizam's Dominions	1	...
Sind	1	1

19. In addition, we have had at the College during the last year a candidate for the Provincial Civil Service, who has been recommended to take certain special classes for a year.

University Examinations.

20. During the year under report the first examination has been held by the University under the new regulations, and the following list shows the number sent up, the passes, and the failures:—

	Sent up.	Passes.	Failures.
First Examination in Agriculture ...	25	15	10
Second Examination in Agriculture ...	39	33	6
Bachelor of Agriculture Examination ...	34	26	8

Three candidates obtained a First Class in the First Examination, and one was placed in the first class in the final Examination for the Degree.

21. During the last year second and third year men were much handicapped by a number of supplementary subjects, which had to be taken in order to pass from the old L.Ag. course to that now laid down for the new B.Ag. Examination. Thus in addition to the ordinary subjects, they had to pass in the following:—

Candidates for the Second Examination.—Zoology, Geology, Veterinary Science (new F.Ag. Examination), and Mensuration.

Candidates for the final Examination.—Zoology, Geology, Veterinary Science (new S.Ag. Examination), Entomology (new S.Ag. Examination) and Agricultural Engineering.

While, it may be recognised that it was necessary that the men should pass in these supplementary subjects, yet the combination of these extra matters with what was already a full

course led to excessive strain on the students. It involved, as will be readily seen, that the second year men had to take twenty-one examinations (twelve papers and nine practical examinations) and that those who were sitting for the final examination had to appear in twenty-three Examinations (thirteen being papers and ten practical examinations)! Few of the men did themselves justice under these conditions, as would, indeed, be expected. A special suplementary term was held from January to March 1908 to deal with these supplementary subjects, but though this made it possible for the men to face the examination, yet it was a case of hard, almost hopeless, grinding throughout the year. This difficulty is, of course, a purely temporary one, and will completely disappear after the present year. To relieve the strain somewhat, the University has agreed, in the meantime, not to count failure in these supplementary subjects as total failure, and to allow them to be taken again by themselves.

22. I have already referred to the further changes, more especially with a view to re-arrangement, in the ordinary course, now under the consideration of the University.

23. A word may be said as to the five first year students who are not eligible for the University examination. A special College examination was held in February for these men. All did well, and four of them were placed as equal to first-class in the University. As a whole, they are quite equal to the University students.

Agricultural and other tours.

24. At the beginning of October 1908 plague was serious in Poona, and cases appeared on the College farm, while dead rats were found in the College quarters. It was hastily determined to close the College for a month, and during this time to allow the students to take their annual tours. These were held as follows: —

(1) *Third (final) year students.*—Agricultural tour, under the control of Mr. W. Roberts. They were away from September 29th to October 17th, 1908, and visited Bassein Surat and district, Baroda, Nadiád, Chhárodi, Dhulia, Ahmednagar, Gadag, Dhárwár. Belgaum and the Gokák canal area.

(2) *Second year students.*—Surveying and levelling work, under the control of Mr. H. K. Mehta. They stayed at Ahmednagar from September 28th to October 10th, 1908, and surveyed some of the land in its vicinity.

(3) *First year students.*—Geological tour, under the control of Mr. H. E. Annett. They were away from September 30th to October 9th, 1908, and visited Gokák falls, Belgaum, Castle-rock, Londa, Dhárwár, Gadag, Bijápur, and Bádámi.

These tours serve an exceedingly useful purpose in the training, in addition to their immediate purpose, in showing the students a wide variety of conditions, and I would not be without them as an integral part of the College course.

25. In spite of the utilisation of the time in this manner, the occurrence of plague led to a lamentable breach in the amount and the continuity of the work. A little time was gained by closing the second term on January 31st instead of January 22nd, 1909, but the loss was never really made up.

Scholarships.

26. Under the present arrangements, eight scholarships of Rs. 15 per month, with free tuition, are annually awarded by Government to students who have passed the Previous Examination, selected by the Director of Agriculture, in consultation with the Principal of the College. These are given, by preference, to the sons of agriculturists, and each is awarded for the three years occupied by the course. During the three years, since their institution, they have been awarded to students from various districts as follows: —

	1907.	1908.	1909.
Deccan	3	2	...
Southern Marátha Country	2	2	3
Gujarát	3	2	2
Konkan	...	2	1

Of those appointed in 1907, one student failed in the University Examination in 1909, but has had the scholarship continued as a special case: no less than four scholars of 1908 failed in the University Examination in 1909, and one dropped out of the course. The scholarship was withdrawn from two of these, but the remainder have been allowed to retain them: the scholarships thus vacated have been awarded to two other students of the same year.

27. In 1909, a new scheme of scholarships was introduced. The number available was increased to twelve, of which six were awarded as before. These have been granted as follows: —

Lingáyats	2
Maráthas	1
Anavla Bráhmins (Gujarát)	2
Habbu (Kánara)	1

The remaining six have been awarded to Matriculates of the Bombay University, to enable them to study a year at an Arts College (and so pass the Previous Examination) before joining the Agricultural College. The object of this has been to obtain more men from the agricultural classes themselves. It is often found that these study for and pass the Matriculation Examination, but rarely go further. As this is the class for whom the College is specially designed, it seemed wise to give selected boys special facility for reaching the educational standard needed to enter the agricultural course. It appears likely to be a very successful move, as desirable candidates offer themselves in considerable numbers, and we can, moreover, actually pick out likely boys from the high schools ourselves.

28. The scholars from Sind are on a slightly different footing. They are appointed by the Commissioner in Sind and their scholarship is of the value of from Rs. 25 to Rs. 35 per month according to circumstances, but they have no free studentship. They are, moreover, not required, necessarily, to have passed the Previous Examination and in this case cannot, of course, work for the University degree. They, however, take precisely the same course, and are required to pass an examination of equal severity at its termination. The scholars appointed have been as follows:—

1907.—Three scholars, all of whom had passed the Previous Examination. One of these failed in the First year's University Examination, but his scholarship was continued for another year when he again failed. His scholarship was then withdrawn.

1908.—Two scholars, neither of whom had passed the Previous Examination. One of these withdrew from the College in January 1909, owing to ill-health.

1909.—Two scholars, one of these has passed the Previous Examination; the other is only a Matriculate.

29. There are a number of scholars appointed by other Governments and public bodies in the College, as follows:—

	Date of entry.			
	1906.	1907.	1908.	1909.
Government of Eastern Bengal and Assam	...	3	1	2
Government of Bengal	...	...	1	...
His Highness the Nizam's Government	..	...	2	...
Government of the Central Provinces ...	1	..	...	...
His Highness the Gaekwar of Baroda's Government	2	...	...	2
Lingáyat Education Fund ...	2	1	1	4
Marátha Education Association ...	...	1	...	...
Infanticide Fund, N. D. ...	...	...	1	...

Library.

30. At the commencement of the period under review there was practically no College Library. On the separation from the College of Science being completed, a number of books, chiefly on Agriculture, botany, and Veterinary Science, were handed over, and, though many of the volumes were old, these formed a nucleus for the future. Others were kindly presented by the Professor of Agriculture, by the Agricultural Chemist, and by the Director of Agriculture, and these, together with purchases, have made it possible to increase the number of volumes to 1,182. This, it must be recognised, is only the commencement. It has been decided by the Director of Agriculture that the College Library is to be the Central Library of the Agricultural Department, and if this is the case, it is absolutely essential that it should be made as good as possible. A grant of Rs. 6,000 has been sanctioned for the current year, and it is hoped, if this can be continued for the next two or three years, that it will be sufficient to bring the Library so up-to-date that a much smaller annual grant will then suffice.

College quarters.

31. The quarters, belonging to the College, for the use of students were built many years ago, and only accommodate twenty-eight men. As the College has been far away from Poona City, it has been necessary to provide additional room for the students. This was made possible by a special grant of Rs. 2,400 per annum sanctioned by Government early in the year for the hire of bungalows for this purpose. Three bungalows were in fact engaged, and accommodation thus could be provided for about seventy-eight students in the College year running from June 1908 to Janunry 1909. Similar, but more convenient, arrangements have been made in the session commencing in June 1909, and it is now possible to accommodate ninety-four men. Almost the whole of this provision is utilised, though a few students still live in Poona City.

32. The room rent at present charged is Rs. 12 per annum. As many of our students are relatively poor—and are likely to be so in a greater measure in the future as the proportion who come from the Agricultural classes becomes greater—it is of great advantage if the rent asked remains as low as possible.

Other matters.

33. It has already been mentioned that during the year twenty-six students graduated, and passed out of the College. Hitherto, the Agricultural Department has been able to absorb most of the graduates, but as it is becoming more fully staffed, and as the number of graduates increases, a considerably wider opening than has hitherto been needed, is required. Of course, there are always a certain number of men who will go back to manage their own land, or who will go in for farming themselves. The ultimate success of the College depends very largely on the extent to which it is able to attract such men. But under the conditions of the Bombay Presidency, where large land-owners are rare, it is probable that for a good many years to come, most of the students, whether they belong to the agricultural classes or not, will join the College and pass through the course primarily with the idea of putting their training to use either in the service of Government or of local public bodies. I think this is, in many ways, a good thing. It has long, I believe, been the declared policy of the Bombay Government to encourage the infusion of a certain number of men trained in agriculture into the ordinary revenue service, and, hence, it has been anticipated that there would be a considerable number of openings in this direction for agricultural graduates. I feel that the men who now graduate from the College are well worthy of such encouragement. They have had an intensely practical course: they have worked with their own hands on the land: many of them become, at any rate in the latter parts of their course, enthusiasts in the cause of agricultural improvement: and, judging by a number of the graduates whom I have had the chance of watching closely, many of them show a marked amount of originality. I think it would be good if, at any rate, during the early years of the College, marked preference could be shown for appointment to the revenue service to graduates in agriculture: after a few years they will be known, and will, I believe, be preferred on their own merits.

34. The staff of the College has worked well and enthusiastically. One matter, in this connection, deserves special mention. The course in practical agriculture, thanks to the strenuous efforts of Mr. Knight and the members of his staff, is now carried to a very high pitch of efficiency, and a student who passes through our course in the future will have a personal knowledge, derived from his own work, of the actual difficulties of agricultural practice and how to meet them, which has hitherto been unobtainable. Every student has now to be able to use all common farm implements, to cultivate with his own hands several crops during a whole year, and to manage a large area during at least one *kharif* and *rabi* season. He has, in addition, the management and feeding of dairy cows in his hands for a limited period, and will, in the future, have practice in the treatment of the common diseases of farm animals. I think the greatest credit is due to Mr. Knight and his staff for the way in which this course has been improved and organised until it has reached its present stage of efficiency.

Short course.

35. At the end of the year a new departure has been made, experimentally, at the College, which demands a reference here. There has long been a demand for a training in practical agriculture by men, who, though knowing English, were not able to reach the high standard of general education required for entrance to the University course, and who, also, were not able to give three years to the study. This has resulted in the initiation of a new course, on an experimental scale, during June 1909. It will last for nine months, and will be essentially practical, and has been commenced with four students. If successful, it is probable that proposals will be made for putting it on a larger and more permanent basis.

HAROLD H. MANN,
Principal.

APPENDIX F.

Report of the Agricultural Chemist for the Year 1908-1909.

1. The office of the Agricultural Chemist to the Government of Bombay, situated in the buildings of the Poona Agricultural College, has been in my charge during the year under report, except from August 3rd to November 2nd, 1908. During the greater part of this latter period (August 29th to November 2nd), when I was absent on sick leave, the work was in the very efficient hands of Mr. H. E. Annett, Supernumerary Agricultural Chemist at the Pusa Research Institute, whose services were very kindly lent by the Government of India.

2. The work done by the Agricultural Chemist's Department divides itself into two very distinct sections. On the one hand it forms the central analytical laboratory for the Bombay Presidency in all matters relating to agriculture,—a function which involves a constantly increasing amount of more or less routine analysis:—on the other, it is intended to be a research centre, in which investigations are carried on from a chemical point of view for the improvement of the agriculture of the Bombay Presidency. It will be well to consider the work done under each of these headings separately.

3. The routine analytical work of the laboratory remains very large, as is indicated by the following figures, which show the number of samples examined in each of the last three years:—

Kind of sample.	Number of samples examined.		
	1906-07.	1907-08.	1908-09.
Soils	67	101	311
Manures	43	105	91
Feeding stuffs	17	41	17
Water	22	80	266
Gul and sugar	32	76	7
Beet-root	...	...	36
Oils and oil-seeds	47	98	146
Milk	233	666	257
Condensed milk	...	...	2
Cream	123	1	1
Butter	2	2	2
Miscellaneous	10	22	17
Total ...	596	1,192	1,153

The slight decline in the numbers of the present year is due to the fact that the samples received daily from the Kirkee Dairy in 1907-08 have only been sent occasionally in the year under report. On the other hand the number of samples of soil and water, as well as of oil-seeds, shows a very marked increase.

4. By far the larger proportion of these samples came from the various farms and officers of the Agricultural Department. This is naturally the case at present, but as the laboratory becomes better known there is a gradually increasing number of inquiries addressed and samples sent from private individuals in all parts of the Presidency. This is really, I feel, the test of the success of the work. So long as little else than Departmental work is done, so long one must feel that the Agricultural Chemist's laboratory is only serving the smaller half of its purpose. It is only when it becomes the natural court of appeal to cultivators in difficulties, or to merchants in buying and selling agricultural products, that one can feel that it is playing its proper part. The number of samples which have been received from such private individuals has been as follows during the past two years:—

	1907-08.	1908-09.
Soils	15	14
Manures	12	11
Feeding stuffs	3	2
Samples of water for irrigation or drinking ...	11	16
Milk	...	4
Miscellaneous	...	7
Total ...	41	54

The progress of the laboratory in the direction of being utilised by the general agricultural public is, therefore, slow and gradual, but definite.

5. Among the samples received by the laboratory during the past year, those of soil and water occupy the principal place. These, however, are, in by far the largest proportion, samples of soil which is damaged in greater or less degree by the presence of salt in the land, and of water whose use for irrigation is more or less doubtful on account of the presence of varying amounts of salt. Many of them were brought by my assistants and myself in the course of an investigation (referred to later) of the salt lands of the Nira Valley. The importance of the question of salt in the soil, as affecting the crops which can be produced in land, in all the black soil areas of Western India has not, I think, been yet fully realised. In large numbers of cases, the land is injured for many crops without any appearance of salt being present. I may cite one such case which came into my hands during the current year. A sample of soil and water were sent to me by a cultivator in Dhárwár with the following remarks:—"The soil becomes very much waterlogged on irrigating it or after a heavy rainfall. My grandfather has taken a good outturn in his time. It is only 15 years that the soil has become so. I have now left it untilled for nearly eight years. Crops on dry land now failing successively for eight or ten years on this soil, my lands instead of becoming a support to my family have become a burden." In this case there was no obvious salt in the soil, no incrustation whatever, and all that was visible was the hopeless physical condition which led to waterlogging by even a small quantity of rain. On examination of the irrigation water the cause was fairly obvious. The water as well as the soil was distinctly alkaline, and gave on analysis the following figures:—

Calcium carbonate	...	... 5·0	parts per 100,000
Magnesium carbonate	...	... 7·6	„ „
Sodium carbonate	...	... 24·5	„ „
Sodium sulphate	...	... 26·2	„ „
Sodium chloride	...	... 30·0	„ „

These figures indicate a water which, apart from the presence of sodium carbonate, would be an excellent one for purposes of irrigation; but this salt, though not present in large enough quantity to cause incrustation, yet in the absence of carefully arranged drainage, is quite able to make the highly basic soils of the Bombay Presidency absolutely incapable of growing almost any crop. Once the land is damaged in this way, drainage becomes impossible, and apart from some expensive chemical method of neutralising the salt, and so rendering it again capable of being drained, the land *must* pass out of cultivation. It is fortunate indeed, that while soluble salts are common in the black soils of Bombay, sodium carbonate is relatively uncommon. The extreme evil indicated above, therefore, rarely occurs, and the land affected by such salts still responds to carefully arranged drainage. If sodium carbonate were common, in the highly basic black soils of Bombay, the case, once the evil had been effected, would appear to be at least an extremely difficult one.

6. I will refer to another series of samples connected with the development of salt in the soil received from the Bijápur District through the efforts of the Director of Agriculture. It is well known that the water of the Don river in Bijápur was formerly used largely for irrigation purposes. The memory of the people and the presence of large numbers of 'Budkis' on its banks testify to this fact. But in recent years, probably during the last thirty years by all accounts, it has become exceedingly salt and hopeless for irrigation purposes. Samples were accordingly sent to me from various points along the course of the river, in order to determine whether there was any particular spot where the infection with salt took place. The result was exceedingly interesting. It is probable that the water has always been fairly salt, though still capable of being used in small quantities. But the great increase of salt takes place at a very marked and distinct point in the river, as the following figures show:—

Distance from the entrance of the Don river into the Bijápur District.	Sodium chloride parts per 100,000.
19½ miles	193·7
22 „	81·0
31 „	242·6
32 „	1,426·0
38 „	919·3
48½ „	581·9
58½ „	362·1

It seems very probable, in fact, that the chief part of the difficulty is produced by one or two tributaries which reach the main stream between the 30th and the 32nd mile, and the investigation is being continued with this in view. It is difficult to see how the evil can be remedied even when it has been completely localised, but some method may easily appear when all the circumstances are known.

7. I wish to insist on the importance of the question of the development of salt in lands in the black soil areas of Bombay. The injury done is undoubtedly greater and

more extensive than is commonly supposed, and very many areas which still grow successful crops, though they show no incrustation, are, from the samples which have reached my hands, very seriously affected by reduction of the crop caused by the presence of salt in the land. I will return to this matter at a later part of this report.

8. A very large number of samples of manure were received, chiefly however from the Government farms. But among these samples of manure were some of sufficient interest to be worthy of remark here. The first of these is a sample of cotton cake, partially decorticated, received from Messrs. Girdharlál Raichand and Company of Broach. It is well known that hitherto all attempts to found a cotton seed crushing industry in India have failed, partly owing to the nature of the Indian seed, and partly to the conditions under which the manufacture has been attempted. The cotton seed has, in fact, been either used as a feeding material as it stood, or else it has been exported and crushed in Europe. An attempt on a larger scale is, however, now in progress to utilise the cotton seed by pressing here in India, and the cotton seed cake produced by the Broach mill forms the sample under consideration. It was a partially decorticated cake, cleanly made, and excellent in appearance, which gave the following figures on analysis :—

Moisture	5·27	per cent.
Oil	7·33	„
*Albuminoids	26·62	„
Soluble Carbohydrates	38·17	„
Woody fibre	15·56	„
†Mineral matter	7·05	„
	100·00	
‡Containing nitrogen	4·26	per cent.
§Containing potash	1·25	„
„ phosphoric acid	2·53	„
„ sand	1·50	„

As will be seen, this cake is not only an excellent manure, but also a good feeding material. If a cake of this quality can be regularly produced, there should be no difficulty in disposing of very large quantities for both purposes. As a manure it is quite equal to the average of the samples of Gujarát castor cake which have passed through my hands. The finer part of the refuse produced in the decortication process is still of considerable value as a manure, and gave the following figures on analysis :—

Nitrogen	3·83	per cent.
Potash	1·96	„
Phosphoric acid	1·69	„

It would not pay to carry this material far by railway, but it is nevertheless very valuable as a local manure.

9. The demand for oil-cakes as manures in the Bombay Presidency is continually increasing, and on the whole the most popular seems to be castor cake from Northern Gujarát, sold under the name of "Sábarmati Castor Cake." It usually contains between 4 and 5 per cent. of nitrogen, and forms an excellent manure. Its popularity is, however, apparently leading to a certain amount of adulteration with "Mhowra" cake, which is much poorer and for which there is practically no demand. Usually the latter only contains about from 2 to 3 per cent. of nitrogen, but once incorporated with the castor its presence is not easy to detect without microscopic examination. The fact that this adulteration is carried on lends increasing importance to the necessity of oil-cakes as manures being bought on analysis, on a basis of unit value, and not merely on appearance. It would certainly be wise that whenever cake is distributed or sold to cultivators (as is now being done by Government Agency at Báramáti in the Nira Valley) it should be so distributed after analysis. Neglect of this precaution may have been the cause of unsatisfactory results occasionally obtained in the past.

10. Practically no other manures but oil-cake and fish are purchased by cultivators in the Bombay Presidency. The price of these has, however, now gone up to such a point that it is questionable whether sulphate of ammonia cannot compete with them at any rate for sugarcane. If so, a demand might be fostered, and as it is, I believe, now made and utilised in India. The following are the current values per one per cent. of nitrogen per ton of the following manures for sugarcane at Poona :—

	Rs.	a.	p.
Dried fish	11	4	0
Safflower cake	9	8	0
Castor cake	12	4	0
Sulphate of ammonia	9	10	0

It will be seen that safflower cake is at present the only cheaper form of nitrogen under these special conditions.

11. One of the most interesting investigations in progress in the Agricultural Department is as to the amount of oil contained in different varieties of oil seeds grown under varying conditions. So far the experiments have been limited to til, castor, and groundnut. Of the results in connection with the two former, nothing can as yet be said, but with regard to the groundnut the conclusions are now fairly clear. It was, as a result of the first year's experiments, thought that the exotic varieties as a whole were richer in oil than the indigenous groundnut. This has, however, now been proved not to be the case. There is in fact no constant relation of the percentage of oil in the seed to the variety, and this percentage seems to be determined much more by the circumstances under which a particular variety is grown than on the nature of the variety itself. Thus the same seed grown at Surat or Dhárwár nearly always gave a richer nut than when grown in the Deccan districts, and the amount of cultivation seems to exert more influence than the nature of the variety on the percentage of oil.

12. We may now turn from what may be called the routine work of the Department to the special research work in charge of the Agricultural Chemist. This has mainly gone on on four lines :—

(1) The improvement of salt land in the Nira Valley.

(2) The meaning and use of "*Ráb*" in the preparation of the seed bed for rice.

(3) The variation due to season in the composition of well waters in the Deccan and other areas situated on the trap rock of Western India.

(4). The composition of the milk of Indian cows and its variations.

I hope to publish shortly an account of what has been done in each of these directions, but in the meanwhile the results of some of them may be given in a very brief summary.

13. The improvement and reclamation of the salt lands in the Nira Valley has been a matter of importance for a number of years. It is well known that, following the introduction of canal irrigation, the area of such land began to extend with great rapidity. This extension has been slower in recent years, but is almost certainly still going on. As a result of the work of the last two years it is now clear—

(*a*) that almost the whole of the development of the salt land can be traced to the rise in the ground water level. If this can be lowered, the evil will not spread to anything like the same extent, and some of the lands may be recovered ;

(*b*) that in cases of moderate amounts of salt, deepening of the main drainage channels of the country, and the cutting of a smaller number of feeder drains is rapidly effective in improving the land and cleaning the salt ;

(*c*) that even in serious cases adequate drainage is quite effective in clearing the land of the salt ;

(*d*) that salt rice, obtained from the districts near the sea in the Konkan, will afford a crop in many cases during the reclamation of the land.

The result of this investigation is, in fact, in all except the worst cases, to show reclamation to be a comparatively simple and relatively inexpensive matter, and I hope to submit a special report on the subject in the very near future.

14. The question of the meaning and use of "Ráb," in the preparation of the seed bed for rice is an exceedingly important one. The process termed "Ráb", as is well known, consists in burning a mass of branches of trees or cowdung on the land where a rice seed bed is to be placed, some time before the rains. It is almost universal in all the trap and laterite regions of Western India, where, it is stated, it would be difficult to grow rice without it. My experiments must be considered as, however, simply supplementary to those conducted by Mr. Knight at Lanowli.

From my own work, however, it appears clear now—

(*a*) that the heating of the soil is the chief factor in the value of "*Ráb*". About two-thirds of the effect can be obtained by the heating alone ;

(*b*) that there is no virtue in the particular method adopted in heating the soil. If it be scraped from the surface, and heated in a kiln with about one-fourth of the fuel an equal result will be obtained ;

(*c*) that the heating causes three principal changes in the soil—

(i) the alteration in the number and proportion of the different bacteria in the soil ;

(ii) the making soluble of a considerable amount of organic nitrogenous matter in the soil ;

(iii) the improvement in the physical condition of the land.

Which of these causes is the dominant one I am not yet prepared to say, but the results so far indicate that both (i) and (iii) take a part. My results, in conjunction with those obtained by Mr. Knight, seem as if they would shortly lead to a complete elucidation of the very complex and important question of the use of "Ráb" in rice cultivation. I hope to publish an account of results to date at the end of the present rice season.

15. The first stage of the work in the composition of the milk of Indian cows is now completed. This was commenced by my predecessor, Mr. Meggitt, and has given exceedingly interesting results. These indicate how, with Indian as with European cows, it is absolutely essential in running a dairy to constantly check the composition of the milk of the cows and buffaloes if the best results are to be obtained. It is evident, in fact, that so far as the breeds in use at the Poona Dairy are concerned, the composition of the milk is much more a matter of the individual than of the breed. Extraordinary differences between the richness of the milk of different animals of the same breed were noticed. The milk of individual animals was wonderfully constant in composition, and it was by no means always that the animals yielding the most milk were the poorest. The results seemed to indicate great possibilities of improving the milk of dairy cattle of the breeds used at Poona by a regular process of selection. The detailed results are now being compiled into a paper, which, it is hoped, will shortly be published.

16. It is needless to refer in detail to the numerous other smaller matters which came under investigation. Several of them are ripe for publication—notably the experiments on the sources of loss in the manufacture of gul from sugarcane, and in the work on the variations in the composition of the well waters in the Deccan. They will, all being well, appear in the near future.

17. My staff have worked exceedingly well during the year. Mr. Price, the Senior Laboratory Assistant, has been Superintendent of the Laboratory during the year Mr. Támhane has been engaged most of the time in the inquiry into salt land and its reclamation, and I have every reason to be satisfied with the enthusiastic manner in which the work on this question has been done. Mr. N. V. Joshi, who has been specially engaged in carrying out the very difficult work on the effect of "Ráb" on rice, has been keen and skilful, and his work is worthy of the greatest confidence. Mr. DeMello, who has been responsible for most of the milk analyses, has also worked with great devotion.

HAROLD H. MANN,
Agricultural Chemist.

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Annual Reports.

Annual Report of the Department of Agriculture, Bombay Presidency, for the year 1908-09.

No. 12036.

REVENUE DEPARTMENT.

Bombay Castle, 13th December 1909.

Letter from the Director of Agriculture, No A.—5601, dated 19th August 1909 —Submitting the Annual Report of the Department of Agriculture, Bombay Presidency, for the year 1908-09.

Letter* from the Director of Agriculture, No. A.—3286, dated 20th September 1909.

RESOLUTION.—The Governor in Council has perused the report with great interest. The commendable promptitude with which it was submitted enabled it to be discussed by the Agricultural Conference which was summoned at the end of September 1909. The result of the Conference was to show that the work of the Department and College as described in the report and appendices had excited a genuine and lively interest throughout the Presidency. There can be no question that during the year 1908-09 remarkable progress has been made by the Department in convincing the public that it is doing useful work and has an unlimited amount of such work to do. This progress is due largely to the steady and vigorous efforts of the staff, both Educational and Executive, to get in touch with the people by all the means at their command, whether through shows and exhibitions, through demonstrations on the farms, through the publication of information by means of leaflets, or by the establishment of Agricultural Associations. Practical results were seen in the distribution of the seed of hybrid cotton in Surat with a substantial profit to the growers, the extension of the cultivation of Broach cotton in Dhárwár, the wide and profitable distribution of foreign groundnuts, the keen demand for selected seeds, concentrated manures, improved implements, and even machinery, such as the Cawnpore chain pump and the power cane-crushing machine. Demonstrations at the shows attracted crowds of people, some of whom must have carried away valuable lessons.

2. Testimony like that mentioned in paragraph 21 of the report as being given by the Patel of Kásegaon in the Sátára District to the economy of the Poona sugar-boiling pan and furnace, is an unmistakeable indication of genuine assimilation by the intelligent cultivating class of the information which the Department is able to impart.

3. Cotton and sugarcane bulk largely in the operations of the year. The importance and value of these crops are fully sufficient to justify the amount of attention bestowed upon them, and to account for the interest which has been attracted to the work of the Agricultural Department in relation to them. But the activities of the Department have been extended in other directions too numerous to mention.

4. The Governor in Council especially approves the experiments which are being made in dry-farming, and other means of improving the practice of ordinary cultivation and increasing production by simple processes for husbanding moisture in the soil and preventing exhaustion of its manurial constituents by means of skilful tillage and systems of cropping adjusted to local conditions. He observes also with satisfaction that there is a probability of the researches of Professor Knight and Dr. Mann resulting in the discovery of effective and economical substitutes for ráb in the cultivation of rice. There can be no question that the difficulty of providing ráb is in many places likely to increase rather than diminish. Lands in private occupation are being steadily exhausted owing to the heavy demand upon them for the supply of fuel to the city of Bombay and other towns. The Forest Reserves, so far from restricting the supply of ráb materials, may before long be the only source from which they can be obtained. Much can, it is hoped, be done to retard denudation by

* Not printed.

inculcating proper systems of lopping such as are embodied in Mr. Orr's woodland system, but an incalculable benefit will have been conferred on the rice-growers of the Ghauts and Konkan if means can be found to reduce their dependance on rab materials without increasing the cost of cultivation or diminishing production.

5. Valuable evidence of the interest excited by the work of the Department is to be found in the establishment of ten new Agricultural Associations during the year, the greater number of which have commenced active experimental work. As Mr. Keatinge remarks, associations may best be regarded "not as substitutes for individual work but as the expression of it", and inasmuch as there has been no attempt to force them into existence, their establishment is proof of the development of that individual initiative which the Director rightly emphasises as absolutely essential to the spread of agricultural improvement.

6. The Governor in Council notices with special satisfaction the beginnings of expansion of the work of the Department in Sind under the skilled and judicious guidance of Mr. Henderson. The cultivation of Egyptian cotton received a severe check owing to the failure of the Jámráo and other causes. Mr. Henderson, however, has completely demonstrated the mode in which its cultivation can be made a success. The difficulty will be in inducing the people to adopt his methods, which require not only capital to start with but strenuous labour. Further demonstrations are to be made on a considerably larger scale, and the Governor in Council is by no means without hopes that the difficulty may be overcome when the undoubtedly profitable nature of the undertaking is realised.

7. Among the appendices is included the first annual report of the Poona Agricultural College, which represents the latest development of efforts begun more than twenty years ago to introduce higher agricultural education into the Presidency. The report is both interesting and important. In future years it should be printed in large type with a separate review. The increase of passed students, formerly Diplomates, now Bachelors of Agriculture from none in 1901, one in 1902, to twenty-one in 1908 and twenty-six in 1909 constitutes a remarkable record. The total attendance at the College which in 1909 reached 106 shows a similar upward tendency. Recent revisions of the curriculum, which have been sanctioned by Government, and which were evidently much needed, will increase the popularity of the course while in no way detracting from the practical efficiency for which it is distinguished.

8. At the Conference in September no subject attracted keener interest or more intelligent discussion than Agricultural education. There was evidently a general feeling that in addition to the higher and more scientific education now imparted in English, some provision should be made for teaching necessarily of a less advanced description in the vernacular. Some speakers advocated the teaching of agriculture in primary schools. This, however, as the Director of Public Instruction explained to the Conference, would be wholly impracticable and a mistake if it were practicable. The teaching of agriculture must be given by an Agricultural Expert. The primary school master cannot be equipped for the purpose. A basis of sound, general primary education is the least that is required for learning even the elements of scientific agriculture. But other speakers at the Conference suggested intermediate agricultural classes or schools for the instruction of cultivators who have received enough primary education to understand the instruction to be imparted in the vernacular. This object is well worth considering. It is understood that Dr. Mann, Principal of the Agricultural College, has in hand a scheme for starting such classes at the College. The Governor in Council would be glad to receive Dr. Mann's proposals, but is inclined to think that it would be even better if such schools or classes could be started away from the dry-nursing influence of the College—say one in each Division, with an Agricultural Graduate in charge, who would work independently subject of course to inspection and supervision by superior officers of the Department and of the College. Such schools or classes would be located in the vicinity of the farms in each Division and would be open to the vernacular-knowing population of the neighbourhood. The Director and Principal should submit to Government any proposals they would be disposed to make for the

start of such schools or classes. Government will be prepared to find a modest sum for the purpose in the coming year's budget.

9. The Department appears to be peculiarly well-staffed—hardly an officer can be mentioned whose efficiency is not equalled by his enthusiasm. Perseverance on present lines is certain to yield results of the greatest value to the people and the country.

10. Much credit is due to District Officers and private individuals for assistance given in the organisation of shows and associations and other work of the Department. The especial acknowledgments of the Governor in Council should be conveyed to the gentlemen mentioned by the Director in paragraph 40 of his report.

11. In one point only has a note of apprehension been sounded in relation to the work of the Department. At the Conference fear was expressed that increased production due to agricultural improvement might be used as a basis for enhancing the land-revenue assessment. In addressing the Conference, the President gave an unqualified assurance that this fear was entirely groundless. Government desire to confirm this assurance without any reservation whatever. One of the fundamental bases of the revenue system of this Presidency is the entire and perpetual exemption from assessment of improvements effected by the rayat. This exemption extends to every class of improvement including improvements in the processes of agriculture no less than works of improvement such as wells, bunds, tils and the like. No opportunity should be lost of impressing on all classes of the cultivating and land-owning population that no violation or evasion of this principle will ever be countenanced or tolerated by Government.

R. D. BELL,
Under Secretary to Government.

To

The Commissioner in Sind,
The Commissioner, N. D.,
The Commissioner, C. D.,
The Commissioner, S. D.,
All Collectors, including the Collectors and Deputy Commissioners in Sind.
} With one copy of the Report, and with an intimation that the requisite number of copies of it will be supplied to them by the Director of Agriculture.

The Director of Agriculture and of Co-operative Credit Societies,
The Settlement Commissioner and Director of Land Records,
The Conservator of Forests, N. C.,
The Conservator of Forests, C. C.,
The Conservator of Forests, S. C.,
The Deputy Conservator of Forests in charge Sind Circle,
The Colonization Officer, Jamrao Canal,
The Accountant General,
The Director of Public Instruction,
The Principal of the Agricultural College, Poona,
The Educational Department of the Secretariat,
The Political Department of the Secretariat,
The Public Works Department of the Secretariat,
The Financial Department of the Secretariat.
} With copies of the Report.

The Government of India,
The Under Secretary of State for India.
} By letter.

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